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A NEW 1,000 UNIT MACHINE FOR ELECTRIC SUPPLY.

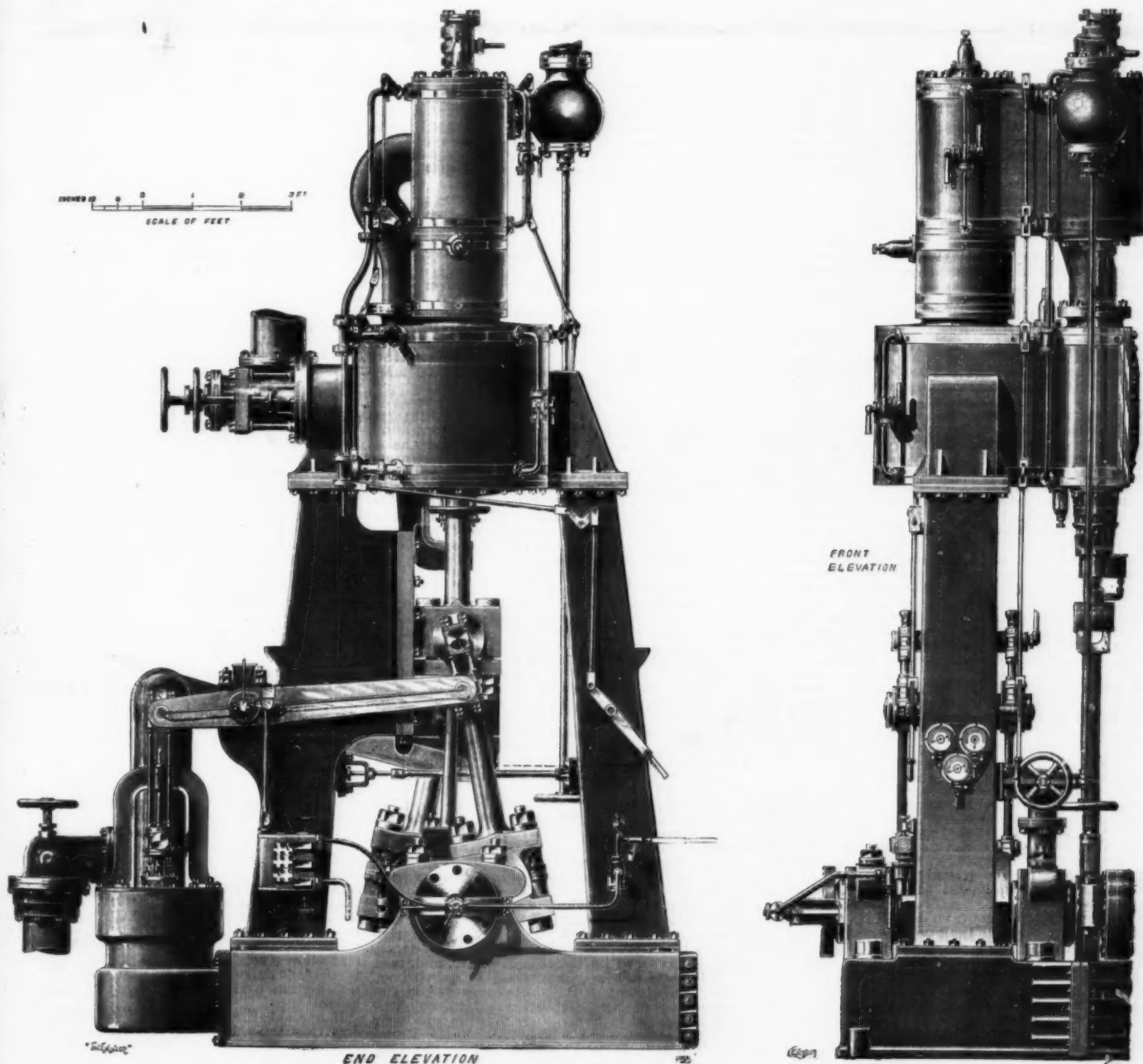
THE history of the London Electric Supply Corporation is full of interest to the public at large, to the users of electricity either for power or light, to the financial world, and in a very special degree to that of science. It is a history of great things attempted and of something done, of pioneer work when it stood alone and without any rival in its field, an educational history of infinite value in which other companies and corporations may have learned much of the things to

stations at present working, and, in a more or less satisfactory way, paying, as being anything but a temporary makeshift. The history of the early gas supply will be doubtless repeated in that of electric lighting. The little stations dotted over the face of London will naturally in turn disappear, and our houses and our streets will be lighted from great central stations situated where coal can easily be obtained, and out of the reach of injunctions, away from the busy metropolis.

The early difficulties experienced with extra high tension have been conquered during the last three or

oblivions on the score of injunctions, the rumors of which in connection with the intermural stations fill the air.

We had recently the opportunity of going over the station, and were much struck with the large increase of plant, both as regards dynamos, engines, and labor-saving appliances, with the great improvements in the switching platforms for mains and machines, and in the electrical connections generally, which have been effected during the last two years. The plant now in commission for the generation of current consists of two small Ferranti dynamos of 225 kilowatts capacity,



A NEW 1,000 UNIT MACHINE FOR ELECTRIC SUPPLY.

be left undone, but in which they undoubtedly did learn much more of the things which should be done. We have on many occasions pointed out to our readers that the generation of current for the lighting of a vast capital like ours must in the future be carried out "beyond the walls." The objections to central stations in the heart of London, in the middle of clubland, in the residential neighborhoods of the West End, or amid the offices and shops of the central districts, will become insuperable with the larger growth of electric lighting. The vibration, the noise, the smoke, the steam, the incessant deliveries of large quantities of coal by road, the discharging of ashes and other refuse in a similar way, would constitute in the future so intolerable a nuisance to the dwellers, the workers, or the thinkers in our great city, that we cannot regard any one of the intermural central

four years at Deptford, and we cannot doubt that in the not distant future low tension and continuous current supply will be relegated to our villages, or private houses, far away in the country. Already the London company is, we understand, engaged in the supply to stations of other companies of a considerable quantity of current daily; and as we presume such a supply is being given on mutually advantageous terms which will pay all round, it will be a matter of surprise if such a system is not more generally adopted, and if the Deptford station is not quickly filled up to its full capacity with plant for the wholesale generation of electric current. The advantages which it possesses for work of this kind in its situation on the river and in its immense engine and boiler houses are evident, while from the nature of the surrounding property and its distance from town it may be said to be

driven by two sets of triple expansion condensing engines, built by Messrs. Plentz & Son, of Newbury, each capable of indicating 350 horse power; two Ferranti dynamos of 500 kilowatts capacity each driven by two horizontal tandem compound single crank Corliss engines, built by Messrs. Hick, Hargreaves & Company, which will indicate 750 horse power each; two Ferranti 10,000 volt dynamos of 1,000 kilowatts capacity each, driven by a pair of compound engines on two cranks, which can, should necessity arise, indicate up to 1,800 horse power each, built by the same firm of engineers; and the latest addition to the plant in the way of a very fine piece of combined engineering consists of a direct driven Ferranti dynamo of 1,000 kilowatts capacity, generating current at 10,000 volts, and which is driven by a set of engines shown herewith, specially designed for it and built by Messrs. Plentz & Son.

The new plant consists of three separate compound engines set tandem fashion over a three-throw crank shaft, the cranks being set as in a triple expansion engine at angles of 120°. Each engine is complete in itself, with its own jet condenser, steam pipe, stop valve, oiling gear, etc., and is guaranteed to indicate 500 horse power, with an initial steam pressure of 140 lb.; but as all working parts have been designed for a much greater strain, and as the boilers at Deptford can be worked, and are worked when necessary, up to 200 lb. pressure, it is clear that these engines are capable of indicating together 2,000 horse power. Mr. D'Alton's purpose in having three cranks was evidently to secure the equable running which might be expected from six turning moments in the crank circle, and in order to carry the equality of these efforts to the highest degree, he put a complete compound engine on to each crank, and did not tread the conventional path of triple expansion. Now, it is a matter of indifference, as far as the equality of the turning moments are considered, whether the engines are indicating 200 horse power or 2,000—a distinct advantage over any triple expansion engine, in which the turning efforts on the crank circle would vary with every alteration in power, indication, or load.

The three high pressure cylinders of the engines under notice are 16½ in. in diameter, the low pressure cylinders being 37 in., and the stroke of all is 26 in., so that there is ample room for the development of the required power. The best modern proportion for compound cylinders is conveyed in the advice of a well known mechanical engineer, who says, "Design a really first class triple expansion engine and then build it without any intermediate cylinder." If such advice had been followed in the present case, the high pressure cylinders should have been somewhat smaller; but prudence is the better part of valor, and there is a distinct gain in having a cylinder as large as 16½ in.

There are no stuffing boxes on the piston rod between the two pistons, the best type of corrugated rod having been adopted, and this has been found to give complete satisfaction. Steam is admitted to the high pressure cylinders by means of piston valves, and the low pressure cylinders are fitted with ordinary flat valves. Each pair of valves—high and low pressure—is driven by a single eccentric, eccentric and valve rods, the latter being well guided in a heavy bracket fixed just below the low pressure valve chest, and all variation of speed is controlled by means of Joy's patent gear, which is fitted into the body of each eccentric, and by means of which the stroke of the valves is varied as may be required. This effect is produced by the forcing hydraulically of the center of the eccentric into either full gear ahead or into any position between that and mid gear. The system has been used on land and at sea for the complete reversal of the engines, and it has been applied with success to locomotives for the same purpose, but, as the reversal of an electric lighting engine is not necessary, the effects have only been carried at Deptford from full gear ahead to mid gear. The fact that the engines always run in the same direction has rendered a "go astern" guide plate also unnecessary, and as a consequence, though the engines are furnished with heavy columns both at front and back, which render the whole structure solid and rigid, they have all the advantages of what is usually described as an open fronted engine. The connecting rods appear to be very short—less than three cranks—but this objection, if objection it can be called, is the practice of our best marine engineers, and perhaps we are inclined to lay too much stress on the advantage of a long connecting rod. A longer one could only have been adopted in the present case with a sacrifice of rigidity, or considerable broadening of base plate, and as the speed of the engine is 150 revolutions, or just over 800 ft. per minute, the short rod is less of an evil than an increase in the height of the engine would be. The crank shaft is of the best mild Siemens-Martin forged steel; it is 10½ in. in diameter, and is made in three interchangeable lengths coupled together in the most approved style—the cranks are, of course, double webbed, and the shaft is tooled bright all over. Each low pressure cylinder exhausts down its back column, and the steam meets the condensing jet on its way down, the injection valve, which is controlled from the front of the engine, being attached to the column.

The air pumps are placed behind the engines, each one being driven by a pair of levers from the cross-head, and means have been provided by which the air pumps can be quickly disconnected, should it be found necessary, owing to failure of water, breakdown or other cause, to work the engines non-condensing. Two valves have been fixed to the eduction pipes of each low pressure cylinder, by means of which the exhaust steam can be passed down to the condenser and air pump, or allowed to escape into the atmosphere. The water necessary for the supply to the condensers is taken from the river at high water into a large storage tank constructed on the wharf behind the boiler house; but as this holds only 600,000 gallons of water and cannot be filled during neap tides, a well has been sunk to a level below that of low water, and from this well it is anticipated that a large augmentation of the condensing water supply will be effected. The whole of the condensed steam and condensing water are returned to the river, the impurities in the river water rendering it useless for boiler feeding, and evidently the difficulties in the way of cooling the condensed water for use again are either insuperable or too costly. Had it been possible to cool the discharge from the condensers of the station, so that it might be used as injection again, and as boiler feed without fear—for the reservoir could be filled with fresh water to begin with—a great gain in efficiency would have been made; but we understand that Mr. D'Alton has fully considered this point, and has not been able to overcome the difficulties. In any case the condensing, as now carried out at this station, is distinctly in advance of that at the other London stations; indeed, it is not too much to say that the question of condensing has not been more seriously faced anywhere than by the London Electric Company. On the occasion of our visit, one of the triple expansion plants was working in parallel with one of the horizontal tandem sets—the vacuum gage of the former engine showing 25 in., and that of the latter 18 in. The new engines are very complete as to platforms, ladders, oil guards and lubricating arrange-

ments and are richly endowed with pressure, compound and vacuum gages, impermeators, speed indicators, etc., and in their coat of bright green, with black and vermilion lining, they reflect credit on their builders, and will no doubt render excellent service to their owners.

The dynamo, a fine piece of engineering, is directly attached to the crank shaft of the engines, no flexible coupling being used, the shafts being rigidly connected by means of nine bolts, each of 2 in. diameter. The machine has been designed for an output of 1,000 units, i. e., 100 amperes at 10,000 volts; but ample provision has been made for the safe working of all parts up to 11,000 volts, and during the progress of the trials the machine was fully tested up to 12,000 volts when running at its normal speed, 150 revolutions, and periodically 80 per second. No difficulty whatever has been experienced in working the new unit in parallel with any of the other dynamos in the station, and it is proved that it can be put into parallel even with the smallest, and withdrawn without the production of any irregularity in the continuity of supply. No pains in design or workmanship have been spared to render the new machine worthy of the reputation of Messrs. Ferranti; and it would be difficult indeed for the most hypercritical engineer to pick a hole or find a fault in the mechanical or electrical finish of this splendid addition to the Deptford plant. For our illustrations and the accompanying particulars we are indebted to the Engineer, London.

THE ARC LIGHT.*

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.
LECTURE I.
PHYSICS OF THE ARC.

It is narrated of Faraday that he had a particular dislike for what he called "doubtful knowledge;" and it was one of his great achievements in electrical researches to clear up a number of things that came under that category. Some small fact had been discovered, it was obscure, it was not correlated to anything else. So long as it was not correlated to anything else, and not explained, it was unsatisfactory. And though science has gone on since Faraday's time, has developed, extended itself, become correlated all round, while now there are a hundred workers where formerly there was but one, still there are some branches of science in which knowledge is still in a very doubtful state. Into the category of doubtful knowledge I venture to put that phenomenon which was discovered by Humphry Davy during the last year of the old century, and received the name of "the arc."

Although arc lamps are to be counted by the million, though the arc light is used publicly in every town and city, though electrical engineers handle it every day, yet it still remains to be true that on the subject of the arc itself as a physical phenomenon, those of us who know most feel ourselves to be very ignorant. So much is still obscure and unknown that—in spite of the researches of many workers—the physical nature of the arc is still a mystery. Many, however, of the complications that beset the inquiry have been gradually unraveled, and every fresh discovery brings the workers nearer to the explanation of that which is still unexplained.

To the physics of the arc, then, we devote this first lecture of the present course; the optics of the arc will claim our attention in the second; while the third lecture will deal with the recent developments in the mechanism of arc lamps.

EARLY DISCOVERIES.

To introduce the subject of the physics of the arc I will begin at the beginning, and briefly recapitulate the things which were discovered in the first instance. It is sometimes said—and you will find it repeated in text books—that the discovery of the arc dates from about 1809. I venture, however, to put the date earlier. It was in June, 1800, that Volta wrote an account of his then newly discovered pile to Sir Joseph Banks, the then president of the Royal Society. The pile having in that way been made public, a few workers in science immediately precipitated themselves upon that invention, and tried to find out all that could be found about voltaic piles. Among those who thus set to work to build voltaic piles for themselves was Humphry Davy, then apprentice with Dr. Beddoes, of Bristol. In September, 1800, Davy recounts how he was able to produce sparks that were visible in daylight from the discharge of his primitive pile; and he found in trying sparks between terminals of different materials that those sparks were of different degrees of brightness.

Among other materials that he names, he mentions that the bright spark visible in daylight was obtained by using well burnt charcoal. He found that to render charcoal well conducting it must be hard, dense, well burned, so as to be metallic in luster, and, best of all, if it were suddenly quenched in quicksilver. This early experiment of Davy's is recounted in the October number of Nicholson's Journal, to which it was communicated in September. Within one year several other accounts are to be found. In the Philosophical Magazine, in the February number for 1801, Mr. Moyes, of Edinburgh, narrates how he had produced sparks in broad daylight from a pile with some 60 or 70 elements. Then we find Davy again (having in the meantime removed to London, and become lecturer at the Royal Institution) describing, in the very first volume of the Journal of the Royal Institution, how he also had obtained sparks of vivid brightness, using still pieces of well burnt charcoal. He describes an apparatus for taking the spark in fluids, and he continued to show this in his lectures on electricity. In that same year—1801 or 1802—Tyndall records that "Davy showed the carbon light with a battery of 150 pairs of plates in the theater of the Royal Institution." Some six or seven years ago I was hunting up in the British Museum, for an entirely different matter, some of the early numbers of the Journal de Paris, and in the course of that search I came across something I had not at all expected. Un-

der the date 22 Ventôse, An X. (March 12, 1802), I found the following entry:

"Le citoyen Robertson, auteur de la fantasmagorie, fait dans ce moment, des expériences intéressantes, et qui doivent sans doute avancer nos connaissances sur le galvanisme. Il vient de monter des piles métalliques, au nombre de 2,500 plaques de zinc, et autant en cuivre rossette. Nous parlerons incessamment de ses résultats, aussi que d'une expérience nouvelle qu'il a faite hier avec deux charbons ardents. Le premier étant placé à la base d'une colonne de 120 éléments de zinc et argent, et le second communiquant avec le sommet de la pile; ils ont donné, au moment de leur réunion, une étincelle brillante, d'une extrême blancheur, qui a été aperçue par toute la société. Le citoyen Robertson répètera cette expérience le 25."

This same Robertson was a Frenchman of Scotch extraction, whose name comes into the outskirts of science in two or three ways. He was the man who introduced the phantasmagoria, and visited London with it at a later date. It is also said that in the same year, 1802, two other persons showed the carbon light, a German of the name of Curtet, and Ritter, of Jena, the famous experimenter upon the polarization of copper plates; but the references are so scanty that one cannot verify the fact. But it is quite certain that in those two or three years of the century it became perfectly well known that a light could be produced in that fashion between two pieces of charcoal.

I may here take two pieces of charcoal well metalized, and connecting them to the wires from a powerful source of current I will perform Davy's fundamental experiment by putting them together, and then separating them to a distance of about ½ inch apart from one another, when at once we get this little flame of dazzling brightness between the two. The flame in this case is really very bright, both the tips of the carbons themselves shine brilliantly, and the flame itself, when using soft carbon of this kind, is very bright indeed. Holding the pencils horizontally, as Davy did, the flame is seen to take an arched form, as the result of the ascending air current. This circumstance originated the name arc, which we retain, though nowadays we hold the pencils vertically one above the other, and have no arch.

If anyone doubts still that the arc light was a known thing before 1808, let him look at this book, John Cuthbertson's "Practical Electricity and Galvanism," published in 1807, wherein, on page 260, there occurs the following:

"Experiment 200. Deflagration of Charcoal by Galvanic Action.—The charcoal for this experiment must be made of some very close grained wood, such as boxwood or lignum vitae, well charred, cut into pieces about an inch long, one end being scraped to a point, and the other so that it can be held by a port crayon fixed to the end of one of the directors; then approaching the point of charcoal to the end of the other director, light will either appear, or the charcoal will be set on fire. The particular management required should be obtained by trials. The light, when properly managed, exceeds any other artificial light ever yet produced."

Further on, at the last page of the book, the very last sentence runs as follows:

"The quantity of electric fluid given out by the galvanic trough when compared with the quantity given out by an electric machine is worth attention. The deflagration of charcoal (experiment 209), which has been accomplished by the galvanic trough, has never been effected by common electricity."

Now, in those early days when Davy was showing this experiment at the Royal Institution, and other people were repeating it, there does not appear to have been any very careful distinction drawn between the mere spark obtained by breaking the circuit between the points and the continuous flame, which, as I have shown you, can be produced by putting the points together and then separating them. If I steady my hand on a stand and hold the points a little distance apart, I get a flame which persists, although the carbons no longer touch one another. If I merely put them together and separate them wide asunder, I get a momentary spark.

It is not very clear from the records that the permanent flame, what we now call the arc, could be obtained; it is rather implied than described. The term "deflagration," used by Cuthbertson to describe a phenomenon which could not, as he plainly says, be produced, as momentary sparks can, by "ordinary electricity," is decisive. However, from the year 1808, there is no question whatever on that point. It was in that year that Davy drew up a kind of circular addressed to the managers of the Royal Institution, saying that he hoped great things in the relation of electricity to chemistry to come from the voltaic pile, and begging them, if possible, to provide the means for purchasing a much larger battery. As a matter of fact, that famous battery of 2,000 cells was obtained by private subscription; and with this battery of 2,000 cells it was that Davy produced the phenomenon that created so much attention, viz., the production of a permanent flame of a great length and dazzling brightness arching over from one piece of charcoal to the other.

If one substitutes for the comparatively soft charcoal that Davy first used, and that the earlier experimenters used, one of the hard carbons of the modern sort, one can manage the flame a little more conveniently. It was well known from about 1820 that the hard carbon obtained from the inside of gas retorts was a really good conductor of electricity compared with charcoal and many other things. It was in that respect comparable to the metals, and, indeed, by Babbage and Herschel the hard retort carbon was actually classified among metals in conducting power. Hard retort carbons were introduced for the purpose of battery plates a little later by Walker, and about 1834 were used by Grove when he wanted to employ nitric acid.

He found that nitric acid would dissolve copper, or iron or silver, such as had been used in some of the earlier voltaic cells, and he was compelled to employ some materials which nitric acid would not attack. He employed both platinum and retort carbon cut into slips. But his battery became known as a platinum battery, and when, in 1843, Bunsen returned to the matter and employed carbon, many people imagined that carbon was Bunsen's invention for the purpose.

* Lectures delivered before the Society of Arts, London, 1896.—From the Journal of the Society.

At any rate hard carbon was coming into use in the arts.

Foucault, in 1843, found that hard carbon sawn in strips was a better material than charcoal for producing the arc light, and artificial carbons were being made. By this time Bunsen himself had suggested the moulding of materials for the making of battery plates. Several patents were taken out for making artificial carbons by Greener, Staite and Jabez Church in England and by Le Molt, Archereau and several others in France. One finds, in fact, that the electrical industry was being provided with the very material required—a hard carbon of good conducting qualities.

About 1844* Foucault definitely proposed the use of pencils of retort carbon for the purpose of making the arc light. It was in 1846 that the first mechanical arc lamp was combined by William Edward Staite. Staite was one of those men whose inventions miss fire by being much before their time. He not only devised the necessary mechanism for an arc lamp, but proposed among other things to use two carbons parallel to one another, exactly in the same fashion that Jablotchoff did some thirty years later. Staite made a number of suggestions and improvements in detail, but does not seem to have worked much at the phenomena of the arc itself. Others, however, worked at it. Grove, the sole survivor of all the men of that time, happily still with us, not then a judge, made some experiments on the loss of weight of the carbons to find out how much carbon was consumed by the light in a given time. He also tried other materials than carbon, and found that the addition of volatile matters, such as sodium or potassium or their salts, increased the length to which the flame could be drawn out without breaking when supplied from a given battery.

Daniell made some experiments, and found among other things that if you took your carbons and produced the arc and let the tips get very hot and then separated them so that the light goes out, and bring them near together, they still do not light unless you bring them into actual contact for an instant. But Daniell found that they could be made to relight by simply passing the spark from a Leyden jar discharge across—to begin the discharge, as it were. This was rediscovered by several persons later. Herschel, Van Breda and Fusinieri all claimed to have discovered the rekindling of the arc by means of a spark from a jar. I here repeat the experiment, using a little Wimshurst influence machine to charge a suitable jar. Even Hertz waves can kindle the arc under favorable circumstances. De la Rive experimented with the arc and examined various other phenomena, including the beautiful rotation of the arc round an iron pole under the influence of magnetism, which had first been observed by Walker.

Foucault, in 1844, made the observation that if the current was passed to form an arc between carbon and silver, the arc was unstable; whereas, if the arrangement was reversed so that the current flowed from silver to carbon, a long and stable arc was produced, giving out that magnificent green light which is characteristic of the spectrum of silver. He made the acute suggestion that the stability of the arc is dependent on the volatility of the material used as poles. He also drew attention to the action of the heat of the arc in metamorphosing retort carbon from the anthracitic into the graphitic state.

Before I go any further I may mention several additional points that were discovered in those early years. One of the first things Davy discovered was that the arc would burn under liquids. I will take these two carbon pencils and dip them into a vessel containing paraffin oil. On touching them together and separating them I obtain a fitful, uncertain light; there is a great deal of heat produced and it gives off vapor, but as long as the oil itself remains cool, there is no fear of the vapor taking fire. The light is also toned down to a more agreeable golden tint than is the case when one takes the arc in air. If I put these carbons down into water and in the same way make contact, I get a whiter arc, which also is still more fitful. A quantity of gas is given off, some of which is hydrogen, which condenses very rapidly, some is hydrogen, some is oxygen and there are some compounds of carbon and oxygen also given off.

ARCS BETWEEN METAL ELECTRODES.

Returning to the arc in air, if I were to replace one of the two carbons by a bit of metal, I should get a very different effect. It is impossible to get a very steady arc between two pieces of metal, or even between a piece of carbon and a piece of metal. The kind of arc one gets depends very much on the metal one uses, and also on whether one is employing a metal as a positive or a negative electrode. Here, for instance, I am using a carbon rod for one electrode and a bundle of iron rods for the other. There is an arc between the iron and the carbon, and the iron deflagrates off in a beautiful way in a fountain of ruddy sparks. It looks much more dangerous than it really is. If I take copper I get a very uncertain and flickering light, while the arc is of one color if I employ the carbon as the negative pole, and another color if I employ it as a positive pole. The copper disintegrates off more readily if it is made the positive pole than if it is made the negative pole. I am now employing solid iron; it does not deflagrate so much as the iron wire that I had before.

Now I will take zinc, and I obtain this horrible, roaring, hissing arc. But I may show you zinc under more favorable conditions. I will replace my metal electrodes by carbon ones, and take an ordinary stick of zinc, such as is used in battery cells. I will then make contact to it by touching it with these two carbons. If I make contact a moment with both, and then remove one of them, I shall have an arc between the carbon and the zinc. First, I will so operate that the zinc is the positive and the carbon negative. Then I will reverse the operation so as to have the zinc negative and the carbon positive. In one case the arc is much bluer than in the other, and it hisses much more. The arc is quieter if the carbon is positive and the zinc negative than when the zinc is positive and the carbon negative.

If I employ quicksilver in the same way, I shall obtain an arc which will differ in brightness accord-

ing to whether the quicksilver is positive or negative. More vapor is given off when the quicksilver itself is the negative pole. The quicksilver now is positive; that is, a yellower light and not so bright. The vapor is horribly poisonous, so we will not continue the experiment long. Professor Way, an inventor of a mercurial arc lamp thirty years ago, lost his life by the poisonous fumes.

ARCS AND SPARKS.

Many of the earlier experimenters are extremely vague in the way they describe the arc. They do not give definite statements about the actual amount of the current they employed, and one can only judge of the electromotive force at their disposal by counting the number of cells, and trying to find out what sort of cells they had. Modern science gives us the opportunity of being more precise. We can say exactly what electromotive force we are using, and how much current we are actually sending through an arc. Such arcs as we have in modern practice require an electromotive force of something more than 20 and something less than 70 volts—varying generally from 40 to 50 in the case where continuous currents are employed. Under those conditions the arc produced is a very different phenomenon from that which is produced by sending a much smaller current at a much higher pressure; for then the discharge takes the form of a thin spark. If one sends a spark or a succession of sparks from an induction coil, or from a large influence machine between two brass knobs at a distance from one another in the air, the discharge that one gets resembles the arc to some extent, but really is a very different phenomenon. The discharge one gets in vacuum tubes, between terminals of platinum, across the highly attenuated air, is again a different phenomenon. For in neither of those two cases does the material of which the electrodes are formed play any important part in the phenomenon.

In these cases, as we now know, from the recent researches of Schuster and of J. J. Thomson, there occurs an electrolysis of the gaseous medium. What you produce in these cases is a discharge carried on by gaseous particles, which move about, no doubt, and pass to and fro, and shine, but the light mainly comes from the volatile or gaseous particles, and does not come from the solid matter which constitutes the electrodes; whereas, in the true arc itself, the main light comes from the solid matter of the electrodes, and not from the gaseous matter of the flame in between. So in the production of the arc, a great deal depends—in fact, everything depends—on what that solid matter is. By universal consent carbon is found to be the

much, and make the arc too long, it would begin to flame more and to roar, and would probably go out. On the other hand, if I make the arc too short, it would begin to hiss. Sometimes it hisses persistently when the arc is too short. You then notice another phenomenon taking place, viz., that the negative tip, which ought to be burning away while keeping of a peaked shape, acquires little lumps. There are little projections, technically known as "mushrooms," which appear upon the peak. These mushrooms always occur when the arc is hissing. When the arc is burning silently the mushroom disappears, burning away until the negative carbon comes to its proper conical shape. In the case where alternating currents are used, there is no such difference in shape between the two tips, as we shall see in due course. For the present I am considering the arc as produced when the current is of the continuous kind.

There is some difference in the circumstances attending the production of the normal arc. In America, the practice is to use two pencils of equal size, and of the same quality of solid carbon, usually coppered, and to work with arcs about $\frac{1}{8}$ inch long for a current of 10 amperes; many lamps being run in series. In England, where parallel running of lamps or groups of lamps is more common, the practice is to use as upper pencil a carbon of larger size than that employed for the lower pencil; and the upper carbon is usually "cored" (i. e., made tubular and filled with a core of softer quality); while the length permitted the arc seldom exceeds $\frac{1}{8}$ to $\frac{1}{4}$ inch.

Now there is a great difference in properties between the arc that hisses and the arc that is silent. Not only have you this characteristic difference in shape, but the light is distributed differently from the surface. The quantity of current consumed, other things being equal, is different, and in fact, as I shall show presently, the conditions are completely changed. Now I would like you to contrast the effect produced in an arc burning quietly in that way with what one gets if one tries to form a current between two carbons in the same fashion at a distance from one another, using also a steady current, but employing much greater electromotive force. I have the means here, by a small continuous current transformer, of generating a small current of about 1 ampere, at a pressure of 1,000 volts. The wires from that small continuous transformer are joined up to two carbons here. This long flame is obviously quite a different thing from what one gets by using the same amount of power in the form of a larger current at a smaller pressure. It is totally different from a 10 ampere arc at 100 volts or a 20 ampere arc at 50 volts. There is a little streak of light, but that is really more of a flame color, and the light from the carbon tips is comparatively insignificant.

RELATIONS BETWEEN VOLTAGE, RESISTANCE, AND LENGTH OF ARC.

As soon as electricians began to think about making arc lamps, they had to discuss how much current to provide, and at what pressure. They had to decide as to the thickness of the carbons that was required, and what length they must allow. In fact, they had all manner of things to find out, and among the things they did experiment upon was—What was the relation between the electromotive force, the current, the resistance, the length of the arc, and the size of the crater? They came across a very strange fact. If you consider the arc as a conductor, as a column of flame or vapor conducting the current, you will find that it does not follow the laws of ordinary conductors; when you double its length, it does not offer twice the resistance. It was a very puzzling fact, and the Swedish physicist, Edlund, who first drew attention to this fact, thought it could be explained by supposing that in the arc itself there is a sort of polarization as there is in a secondary battery when you are charging it, or as in a voltmeter when you are decomposing water.* This polarization manifests itself as a back electromotive force opposing the current. Many researches have been made upon this matter, and I have tried to tabulate them.

FORMULÆ SUGGESTED FOR THE ARC.

Edlund..... $r = a + bl$
Edlund..... $V = Ca + Cbl$
Ayrton and Perry†..... $V = 63 + 2.1l$
Frölich..... $V = m + nl$

S. P. Thompson..... $V = m + \frac{nl}{C}$

Mrs. Ayrton‡..... $V = a + \beta l + \frac{\gamma + \delta l}{C}$

VALUES OF THE CONSTANTS m AND n (l BEING EXPRESSED IN MILLIMETERS).

| Authority. | Date. | m. | n. |
|------------------------|-------|------------|------|
| Ayrton and Perry | 1882 | 63 | 2.1 |
| Frölich..... | 1883 | 39 | 1.8 |
| Penkert..... | 1885 | 35 | 1.9 |
| Von Lang..... | 1885 | 39 | .. |
| Von Lang..... | 1887 | 37 | .. |
| Cross and Shepard..... | 1886 | 37 to 39.7 | 1.9 |
| Luggin..... | 1887 | 40.04 | 1.77 |
| Uppenborn..... | 1888 | 40.1 | 2.24 |
| Duncan & Rowland..... | 1892 | 40.6 | 1.6 |

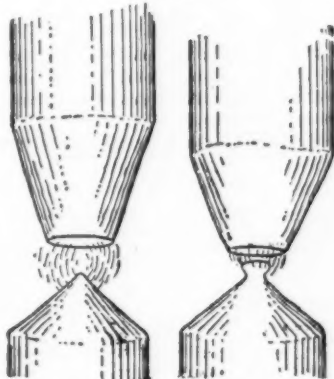
The electromotive force applied to the arc to drive the current through we may call V; it may be otherwise described as the difference of potential across the carbons. Edlund found it to consist of two parts, a part independent of the length and another proportional to the length, l, which symbol, in these formulæ, stands for length in millimeters. As Edlund wrote the formulæ, it was an expression for the apparent resistance, r, in terms of the length, l, and two constants, a

* Edlund considered that he had proved by experiment the existence of a measurable polarization a fraction of a second after the current had been cut off. Although this persistent back electromotive force was confirmed by Latchinoff, more recent experimenters, such as Stenger and Luggen, deny its existence.

† Their formulæ had a small correcting term here omitted.

‡ Added since the delivery of the lecture.

FIG. 1.



SILENT.

HISSING.

only workable material. Moreover, the carbon is consumed at one or both of the electrodes during the continuance of the arc; this circumstance alone constitutes a distinction between the two cases. Now the normal sort of arc produced between two carbon pencils is a thing that will engage our attention far more than any other arc, because it is the normal arc produced between two carbon pencils, which is of industrial value. The others are mere curiosities, so to speak; they may hereafter have an industrial interest, but at present they have only an abstract scientific interest.

THE NORMAL ARC.

What, then, are the conditions of producing the normal arc? We have carbon pencils of the purest and best carbon one can obtain. In most cases one wants a good conducting carbon, and a fairly hard one. The pencils must be put together, and after having been put together, they must be separated to the requisite distance; then the flame springs forth. In technical language, "the arc is struck." The tips become brilliantly white hot; one of them—viz., the positive one—burns away faster than the other. They assume different shapes and the light is found to come almost entirely, by far the greater part of it, at any rate, from the white hot end of the positive carbon.

To examine the conditions of the arc, a lens is arranged so as to throw a magnified image of the arc on the screen, where we can see the shape without being blinded. You will now see in the image on the screen what justifies my statement that the light does not come from the flame in between the two. The arc is now burning steadily, and silently; the current being sent in so as to flow downward. The top carbon, which is therefore the positive electrode, is seen, Fig. 1, to have assumed a flattened form. That is the form assumed by the positive electrode, after being allowed to burn for a few minutes. There is a sort of slightly hollowed crater full of light. The current is coming out from that crater into the flame. There is an almost invisible pale blue flame in between the carbons. The lower pencil has taken a more pointed form, a sort of peak having formed upon it. This negative peak also shines white hot, but we do not get so much light from it as from the other, nor is its light so white in quality. If I hold the carbons at a proper distance apart you will notice that the arc burns quite quietly, and we have a silent flame. If I were to pull the top carbon up too

* Comptes Rendus, xviii, p. 696, 1844.

and b. This we may transform into an expression for the voltage V by multiplying both terms by the current C , as in the second line in the above table of formulae. The terms Ca and Cb are respectively the same things as are denoted by m and n in the formula used by Frölich. They simply mean that the voltage consists of two parts, one constant, the other varying (like a true resistance) with the length of the arc. Edlund did not himself determine the numerical value of those constants; they were not determined, as far as I know, until 1882 or 1883, and the earliest determination of that constant and the variable part is, so far as I know, due to Professors Ayrton and Perry, but I do not understand the figures in their paper, because they make out that the constant part is 63 volts, and the part which is proportional to the length is in volts 55 times the length in inches, minus a correcting term (omitted from the formula for simplicity). The diagram which they gave, which corresponds to these figures, is, to me, entirely unintelligible, unless one supposes that, in 1882, the voltmeters employed measured the voltages nearly twice too high. The other figures here given, with their dates, show a more consistent tale. Frölich, in 1883, found the fixed part 39 volts, and the variable part to be 1.8 times the length of the arc in millimeters; Von Lang found 39 or 37 for the fixed part; Penkert found 35; Cross and Shepard 37 to 39.7; and Lugin over 40.

If we take 39 as about the average of these, we shall not be very far wrong. Now, these 39 volts that one finds as the fixed part apparently have something to do with the properties of the carbons, for if you try arcs with any other material than carbon you get also a fixed number, but a very different one. And if you put into the carbons any other material to make them longer, for instance, soda, potash, alumina, or any metallic salt or metal, the maximum flame may be longer under different conditions, but as a matter of fact the light will be less for a given consumption of energy, and the fixed part of the voltage will also be less. Probably these low members of 35 and 37 are due to the presence of impurities in the carbons.

Now I should like to illustrate this matter by a diagram or two, in which some of these researches are set forth.

Fig. 2 is a diagram illustrating the results of Frölich's researches. The length of the arc from the crater to the peak is plotted out horizontally, the voltage is plotted vertically. In the shortest arc which could be used without hissing, Frölich found about 40 volts to be the amount of the electromotive force which maintained the arc. As he lengthened the arc, the voltage went up in this slightly irregular way. The irregularities may be due either to bad quality of carbon or to the circumstance that the current was not maintained constant, or possibly to the experiments being made too rapidly to allow the arc under each of the successive conditions of length to burn long enough for the electrodes to assume the forms which they would acquire if left long enough. You will note that his curve slopes as though it intended to come down to 39, when the arc is of no length at all. To make a flame of this sort carry a current across from the positive to the negative carbon requires 39 volts, and the additional voltage indicated by the additional height to any point on the sloping line is that which is necessary to drive the current through the flame when the flame has various lengths. The longer the flame, the more are the additional volts required.

Fig. 3 relates to some of the researches of Cross and Shepard. These researches are in many ways very full. For the first time statistics are given, not only for silent arcs, but for hissing ones. They made a number of determinations, trying various kinds of carbons, and also tried the effect of putting in different materials, such as soda and potash. The experiments shown in this figure relate to one particular kind of carbon, but using currents of different strengths; one set when using a current of 5 amperes, another when using 7.9 amperes, another 10 amperes; and they found that, if they pursued the thing down, beginning with a long arc, and gradually shortening it, and adjusting the current to the same amount as before, that the voltage fell in all cases as though it intended to go down to 39 volts, when the length is reduced to an appreciable amount. But as soon as the arc begins to hiss, then the curve changes; there is much less electromotive force required to maintain the hissing arc than the silent arc, and the hissing arc appears to point somewhere to 15, 14, or 13. The hissing arc is very unsteady, however, and the exact form of the curve is uncertain here. To maintain a hissing arc wants very much less electromotive force than to maintain a silent arc of no appreciable length; but in each case there is a part of the voltage fixed, and a variable part depending upon the length of the arc. I might give you, in similar curves, the results of nearly all these experiments; but I should be only giving you the same thing over and over again.

I have found that, by gently blowing sideways on the arc, so as to cause it to take a longer curved path, its resistance is increased; it then requires a higher voltage to maintain the current. The arc is indeed curiously sensitive to winds and draughts. It can quite easily be blown out like the flame of a candle.

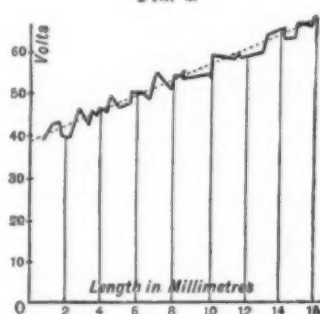
PHYSICAL NATURE OF THE ARC.

I ventured in a lecture I gave here in 1889, on the mechanism of the arc lamp, to make some remarks about this phenomenon. I began, however, from the optical point of view, from the researches of Captain Abney, which will engage our attention next week. Captain Abney had found the white surface of the luminous crater to be always of an equal degree of whiteness, which obviously means that it is always of an equal degree of temperature. No matter whether the current going through the arc is small or large, using big carbons or little ones, or whether the arc is long or short, the whiteness of the crater surface is always alike, and, therefore, of the same temperature. With large currents the area of the crater surface is large; with small currents it is small; its quantity but not its quality changes when the current is altered.

I suggested at that date that the true explanation of this constancy in the intrinsic luminosity of the crater surface was that its temperature was fixed by physical conditions. It appeared that whether the cur-

rent was large or small, the temperature at that surface could not rise and could not fall; that it was, in fact, as fixed as the temperature at which ice melts or water freezes. The only thing that could account for there being a fixed temperature for the crater surface was the fact that the carbon is at that surface in a state of volatilization; that the carbon is evaporating off from the positive carbon into the arc or flame.* At that surface you necessarily must have the temperature at which carbon evaporates, just as you cannot have the surface of ice under ordinary conditions either hotter or colder than the temperature which is taken as zero of the Centigrade scale. If you take a piece of ice and put it in front of the fire, the ice itself does not get any warmer; it simply melts off at the surface, the surface of the solid remaining equally cold, as before. So the surface of a piece of carbon, when in contact with its own vapor, must necessarily be at that fixed temperature. That seems to be now the generally accepted idea.† I want now, however,

FIG. 2.



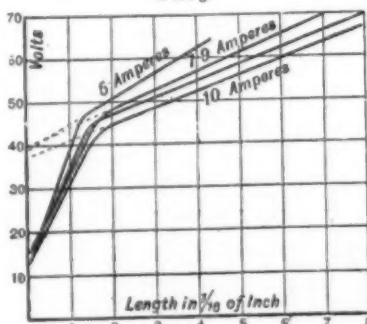
to go a little further, and to suggest another idea to you.

It was found by Despretz, about 1850, that carbon, just before it volatilizes, becomes very soft; in fact, he obtained good evidence of plasticity in carbons when heated up to very near the temperature of the arc. Now that means, of course, that there is, at any rate, an incipient liquefaction going on a few degrees below the temperature of the volatilization. Now the temperature of liquefaction will also be a fixed temperature. If you have a film of literally liquid carbon lying on the top of solid carbon there must be a fixed temperature where they come together at the surface where the carbon is melting. There is some evidence that such films exist over the crater surface; but the temperature of the visible surface of the crater is the temperature at which solid carbon volatilizes. My present view of the physical state of the arc crater is that the solid carbon below is covered with a layer or film of liquid carbon, just boiling or evaporating off.

THE HISsing ARC.

When hissing takes place, a new state of things is set up. If you watch a short hissing arc you will see a column of light concentrating itself on a narrow spot, and that spot keeps moving about, and is very unstable in position as well as in the amount of light it gives out. The contracted spot from which the light seems to start pits deeper into the carbon. I think the first mention of this pitting effect of the hissing arc is not recorded anywhere yet, unless it was mentioned by Prof. Ayrton in 1893, in the paper he read in Chicago, which has never been published. I myself derived the information from Mrs. Ayrton, who made the observation that the crater surface, after the arc has been hissing, is found to be literally honeycombed. When the arc is hissing, you can see little bits erupted out, and the hissing seems to be comparable to the hissing which takes place in water just when it is beginning to boil. If you have some water being heated in such a way that there is not more than a certain quan-

FIG. 3.



tity of heat given off from the surface, you have the water evaporating quietly, but you cannot get more than a certain quantity of heat given off per square inch of top surface of the water in that quiet way. If you force more than a certain quantity of heat to pass off per top square inch of the water, you find the water begins to break up internally, and you have bubbles formed below the surface, the surface breaks up, the bubbles are thrown out, and you have a noisy phenomenon. I think you will find there is exactly the same kind of difference between the silent arc and the hissing arc as between quiet evaporation and noisy boiling. There is a sort of decrepitation, as though

solid particles were being torn asunder to make way for something coming out, when the arc is hissing.* (To be continued.)

THE ELECTRIC CABLE RAILWAY OF THE STANSEHORN, IN SWITZERLAND.

THE lake of the Four Cantons, which is, truly speaking, the heart of Switzerland, is surrounded, as well known, in its multiple sinuosities from Lucerne to Fluelen, by a sort of continuous wall of mountains, often of a pleasing and verdant aspect, but in most cases of a severe and grand one, when their naked rocks hang almost vertically over its waters, and it derives therefrom an incomparably charming aspect. So this lake is the rendezvous of the tourists of all countries, and these, after traveling over it in all directions, are always anxious to make the ascent of the mountains, that dominate it, in order that they may admire it under a new aspect. Modern industry has thus been led to construct those railways of steep gradient that have become so numerous, but which in Europe originated in this region.

The Witznau-Righi railway, the first of all, ran boldly up the side of Mount Righi, which, toward the north, dominates perpendicularly the plain situated between the two lakes of Zug and the Four Cantons. It was later on, through a new line descending to Goldan, connected with the city of Arth, at the point of Lake Zug, and now, at the top of the mountain, it is prolonged toward the south, as far as to the Scheidegg, by a line that in a manner follows the crests parallel with the shores of the lake of the Four Cantons from Weggis to Witznau. Later on, the rack made the ascension also of Mount Pilate, whose summit, situated at an altitude of 2,123 meters, dominates above the Lopperberg the branch of the lake that runs to the point of Alpnachstadt (see accompanying map). At Lucerne, the cable line of the Gütsch climbs the mountain that dominates the city, and permits of admiring the beautiful panorama that it presents, with its antique fortifications, and especially the aspect of the lake, whose shores appear in the vicinity of the city as if enameled with numerous villas and beautiful gardens, while the Alps are seen in the dis-



FIG. 1.—MAP OF A PORTION OF THE LAKE OF THE FOUR CANTONS, SHOWING THE DIRECTION LINE OF THE STANSEHORN CABLE RAILWAY.

These lines of steep gradients, whose construction has often been pursued under difficulties of every nature, present great technical interest, and it may be conceived that a voyage in those regions must furnish the complement necessary to the railway engineer's study.

As long as the gradient does not exceed 7 to 100, the simple adhesion locomotive may suffice, and the line that ascends the Utliberg, near Zurich, furnishes a particularly striking example thereof, one doubtless unique in Europe. Beyond this figure it is necessary to have recourse to the rack, in employing either a central gearing when the gradient remains relatively feeble (less than 25 to 100, as on the Righi and in the most frequent applications) or a lateral gearing, which prevents the lifting of the locomotive when the gradient is steeper, as on the Pilate, where at certain points it reaches 45 to 100. Above 25 to 100, it is necessary to have recourse to the cable railway, and, in a word, to adopt an arrangement that approaches the one employed upon the vertical slopes of mine shafts, and to suspend the car more or less completely from the cable that actuates it.

Switzerland contains numerous examples of these cable lines combined or uncombined with the rack. The latter in most cases borrow their motive stress from the descent of a volume of water sufficient to lift the ascending car. We have described numerous examples of such in these pages.

In certain recent applications, the cable railway is actuated electrically by means of a transmission of force borrowed from a large waterfall located in the vicinity at a greater or less distance. This is the case, for example, with the Stanserhorn line, the last and

* See an excellent lecture on the "Arc Light," by Prof. Elihu Thomson, in *Electrical World*, xvii, p. 168, Feb. 28, 1891.

† Some recent experiments by Mr. W. E. Wilson (see "Proc. Roy. Soc.," May, 1895) are supposed to throw some doubt upon my theory; they are referred to below.—S. P. T.

* For other observations on the "hissing" phenomenon, see: Cross and Shepard, "Proc. American Acad.," 1886, p. 227; Naudet, *La Lumière Electrique*, iii, p. 287; Lugin, *Electrician*, xxvii, p. 566; Spencer, *Electrical Review*, xxxiii, p. 496; Andrews, *Journal Soc. Telegr. Engineers*, ix, p. 26; Cravath, *Electrical World*, xix, p. 195.

not the least curious specimen among the roads of steep gradient of the lake of the Four Cantons. This line, of a length of 3,715 meters, which ascends, starting from Stans, at an altitude of 458 meters, to the summit of the Stanserhorn, at an altitude of 1,900 meters, obtains its motive power from a waterfall situated at Buochs, at a distance of 4 kilometers, upon the River Aa, of Engelberg, an affluent of the lake of the Four Cantons. A 150 h. p. turbine installed upon this fall furnishes a stress sufficient to actuate not only the Stanserhorn railway, but also the small trolley line that connects the cities of Stans and Stansstadt, and the rack railway of the Burgenstock which ascends to an altitude of 870 meters, in starting from Kehrsiten, upon the edge of the lake. The transmission of power furnishes, in addition, the energy necessary for the electric lighting of the two hotels, installed, one of them, at the summit of the Stanserhorn and the other on the Burgenstock.

The Stanserhorn line comprises three distinct sections, each having an independent station of motive

power and an independent cable. Each station comprises a dynamo actuated by the current derived from Buochs, which, through a series of gearings, drives two large pulleys about 4.5 meters in diameter, upon which wind and unwind the ascending and descending cables. These pulleys revolve slowly and make scarcely more than five or six revolutions a minute, giving for the cable a development of about from 60 to 80 meters. The cables are of strong steel wire. The one of the lower section is 25 mm. in diameter and is capable of supporting a stress of at least 25,000 kilogrammes, exceeding by more than ten times that which it furnishes in service. In the upper section, where the gradient is steeper, the diameter is 32 mm. The same two cars, which balance each other continually, the one mounting and the other descending, do service for each section, and the passengers are consequently obliged to change cars in order to pass from one section to the other.



FIG. 2.—VIEW OF THE TRACK AND THE KÄLTİ STATION AT AN ALTITUDE OF 714 METERS.

The track is single, but in order to assure an automatic shunting at the moment of crossings, there has been adopted a system analogous to that of the Giessbach line. Each car carries at one side wheels provided with grooved pulleys which are necessarily guided by the rail, whose head they embrace and deviate with it. The wheels of the opposite side carry, on the contrary, plane flanges, which thus oppose no resistance to the deviation. Each of the two rails of the single track is prolonged without break on the ex-

terior side of the crossing, and thus carries along the car whose wheel it guides. It therefore necessarily happens that the car, guided by the ascending rail to the right, for example, always deviates on this side, either in the mounting or descending, and so too the other car, guided to the left, deviates under analogous conditions. The cable is supported by small vertical pulleys installed in the center of the track, as shown in Fig. 2. These pulleys are inclined in such a way as to hold and guide the cable in the crossings and in the somewhat marked deviations that the line presents.

As for brakes, Messrs. Bucher & Durrer, the engineers of the line, have adopted a very ingenious sys-



FIG. 4.—GENERAL VIEW OF THE STANSERHORN CABLE RAILWAY.

tem of wedges with toothed surfaces that clasp the rails and take a bearing point thereon in order to hold the car. It is, moreover, an arrangement that in certain respects recalls that of the safety apparatus of mine cables. These wedges, to the number of three per rail, are jointed in such a way as to form a jaw that grasps the head of the rail, and are carried along by a shaft that is provided with two screw threads running in opposite directions, and the rotation of which causes them to approach or recede, according to the direction of the revolution. This shaft is actuated by a toothed wheel provided with a counterbalanced lever kept lifted by the cable. As soon as the tension of the cable relaxes it causes the abrupt rotation of the brake shaft through the meshing of the toothed wheel. The wedges are thus carried along and immediately press upon the head of the rail. This head, moreover, is of coniform section, a shape selected in order to assure the complete application of the brake block to the entire extent of the surface that it presents. The least slackening of the cable causes the stoppage of the car within a space of a few meters only, despite the steepness of the gradient upon which it is running. The experiment is often repeated in the control of the state of the line.

A second system of brakes, of an analogous type, is put at the disposal of the conductor of the car, who can control them either by hand or foot whenever he wishes to effect a stoppage.

Besides, a telegraph line running for the entire

length of the roads allows the conductor to keep himself in continual communication with the mechanician at the power station. In fact, it is only necessary for him to establish a contact upon this line by means of a metallic rod with which he is provided in order to set a bell in the engine room immediately in operation and request a stoppage. The mechanician has in front of him an indicator board with a movable index carried along by the motion of the cable, which indicates to him at every moment the position of the car upon the track.

The total duration of the trip is about fifty minutes from Stansstadt to the summit. About thirteen and a half minutes are reckoned upon the first section situated at the foot of the mountain, and which has the feeblest gradient, and is traveled over at the highest speed. Such duration reaches 18 minutes upon the middle and 21.5 upon the upper section, where the gradients are steeper.

The first section ends at Kälti at an altitude of 744 meters. It presents a relatively mean gradient of 12 to 100, but this increases rapidly to 27 to 100 in approaching the station of Kälti (Fig. 2). This section extends at the base of the mountain in traversing a plain with numerous meadows whose verdure contrasts with the aspect of the uncultivated country met with at a greater height.

The second section extends from Kälti to Blumatt at an altitude of 1,221 meters, with a much more pronounced gradient that reaches 60 to 100 at certain points. It first passes through forests of spruce, and then continues to ascend in a particularly wild country through a deep gorge along the bed of an impetuous torrent against which the track is protected by walls. Higher still, in the third section, which reaches the summit of the mountain, the gradient remains almost continually at 60 to 100 in following a completely bare region. It runs through a 150 meter tunnel and crosses true abysses over a viaduct whose construction above these dizzy slopes constituted a truly extraordinary performance.

In a general way it became necessary to protect the track for a great portion of its length by walls and hurdles designed to hold back falling stones. We meet with analogous works upon the great lines constructed in the different valleys at the base of the mountains that surround the lake of the Four Cantons, especially upon Saint Gothard, which rejoins the lake near the point of Flüen. The length of the sections is from 1,200 to 1,500 meters.

The line arrives directly through a small tunnel under the hotel, which is itself situated at about fifty meters from the summit of the mountain. Fig. 3 gives a view of this installation, and Fig. 4 gives a general view of the road. From the summit of the mountain one enjoys an incomparable view. Over the Rozeberg and the Burgenstock, which, seen from this height, appear like feeble eminences, the eye wanders freely in all directions. To the north one sees the cantons of Lucerne, Argovie, Zurich and Zug, and as far as to the chains of the Jura and the Black Forest dominated by the Albis, the Uriberg and the Hauenstein. Opposite, and slightly to the west, rises the Pilate with its peaks, Tomlishorn and Eel, to the west the Schwarzwald with the summits of the Bernese Oberland, and in the bottom of the valley, Alpnach, Sarnen, etc. To the southwest is the chaos of snowy summits and glaciers of the Bernese Oberland; to the south, the group of glaciers of the Titlis and of the Wallenstock, and that of the Glernisch to the east, etc.; and, in returning toward the north by the east, the whole group of the mountains that dominate the lake of the Four Cantons, the two Mythen, the Hochfluh, etc., as far as to the Right.

We have here a wonderful panorama that well explains the attraction that attaches to this fine ascension.—La Nature.

AN INEXTINGUISHABLE COAL MINE FIRE.

THE Evening Telegram, of this city, gives the following graphic account of one of the coal mines in Pennsylvania which has been burning for twenty years. Every conceivable means for extinguishing the fire seems to have been tried without any successful result.

Rats started a fire in a million ton coal vein twenty years ago, and, though science has done valiant battle with the flames ever since, Nature's forces have prevailed, and that million tons of good hard anthracite is still burning, is being uselessly and wastefully consumed.

The history of the efforts to stop the destruction is unique, even in a land where mine fires are frequent. In other exasperating misadventures of this kind men have applied scientific methods with success. Some of Nature's conserving forces have been turned against the destroying elements and have vanquished them. Not so in this case. The contest was unequal from the start. The old gray rats that caused the fire started it where men could not reach in.

At no point on the three black bands which on the geological map of Pennsylvania mark the anthracite region is there a mine fire so little known or involving so great a loss as this. It is far up the side of Locust Mountain, on the north side of Panther Creek Valley, opposite Lansford, in Carbon County. It is isolated and difficult of access.

Acknowledging that the rats got the better of them and wrecked a promising mine, the owners have withdrawn the workmen, until now the number is less than the law requires to bring the place under the official notice of the State inspector of mines, and it is no longer even referred to in the mine inspector's reports.

When I visited what had once been a mine the fire had been marked off within a distinct area and probably the final effort was being made to quench the flame that was consuming what remained of the million tons of coal that once filled the space. Through the baked and parched surface there poured into the air great volumes of polluting gases that showed the fierceness of the combustion underneath. The atmosphere was sickening with the weight of sulphur it carried.

Men just quitting work for the day stopped at a little embankment near us. One with his heavy soled boot kicked away the outer crust and with a stick scraped a little hot pebble on his pipe and after a few draws walked on with his companions, leaving a thin blue trail of tobacco smoke behind.

Their path for the most part lay to one side of the

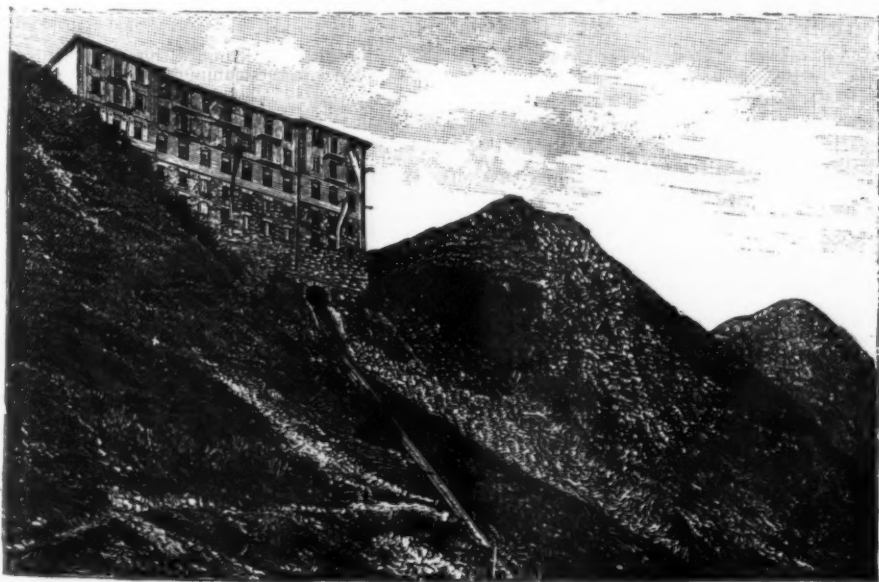


FIG. 3.—TERMINUS OF THE CABLE RAILWAY AT THE SUMMIT OF THE STANSERHORN.

subterranean blaze, but sometimes crossed it. Stephen Harris, the superintendent, who was my guide, at one of these places stepped aside, and to show the extent of the destruction and the intensity of the heat stamped his foot. Instantly his boot disappeared to the knee. Except for the thin crust the superstrata had been disintegrated into powdery dust that was without as much resistance as so much corn meal. When he attempted to withdraw his embedded foot and rested his weight on the other that, too, sank, and he plunged about for three or four steps as if breaking a path in drifted snow. It was terrifying to me, but he laughed at it as an experience he had become familiar with.

"Old Jim" Andrews opened the mine thirty-odd years ago, but its history only became eventful after 1873. Andrews started on a water level and worked along for some years without encountering any serious accident or producing any considerable quantity of coal. He had turned gangways east and west and opened a small number of breasts, proving that coal was there in abundance. Then the Lehigh and Wilkesbarre Coal and Navigation Company, the owner of the land, reclaimed it.

This company, one of the giants of the coal producing organizations, owns all the coal land worth having between Tamaqua and Mauch Chunk, fifteen miles, and operates thereon a dozen large producing mines.

It obtained control of this particular tract of barren mountain land on the original rental of an ear of corn per year, but when the developments had been made and greatly increased rents and royalties were demanded the company acquired title in fee. No. 6, the burning mine, proved its richness in 1870, when an inside slope, sunk 150 yards, found the vein intact.

the fire. In No. 6 the fire spread so rapidly that it was carried into the coal above the water level, and there was no way of checking it except by shutting off the air needed to support combustion.

This was the first effort made. Mortises of brick laid in cement were built across the openings, stopping every hole and crevice through which atmosphere could reach the flame. The mine was apparently hermetically sealed. All pumping of water and air had stopped, and it was thought the fire must soon die out of manition. Men watched on the mountain side for results.

There were no surface indications of fire below, and in two weeks the mine was reopened. The attempt had failed. Then an effort was made to draw the fire, and men mined the glowing coals from below until one after another they were overcome by heat and gas and lives were threatened—some of them lives that would count, as lives are reckoned in the coal region.

General Superintendent William D. Zellner was carried out one day in an unconscious condition, and for hours lay in the brush with excited men working over his inanimate body striving to beat life back into him. At other times men who seemed dead when brought to the surface were packed in an envelope of moist clay, with only the nostrils exposed, and thus they lay, sometimes as long as six hours, before the gas was drawn out of them.

Drowning out was the third method resorted to. Dams to hold the water were built, and water was poured in, but still the heat waves rose from the rocks and proved the fire still raged. When the rain fell little spurts of vapor rose in spots. There the fire was nearest the surface and probably was drawing its

dozen yards away and enveloped them in a great cloud of steam and dust. The drill, wrenched from the man's hands, was found fifty yards below.

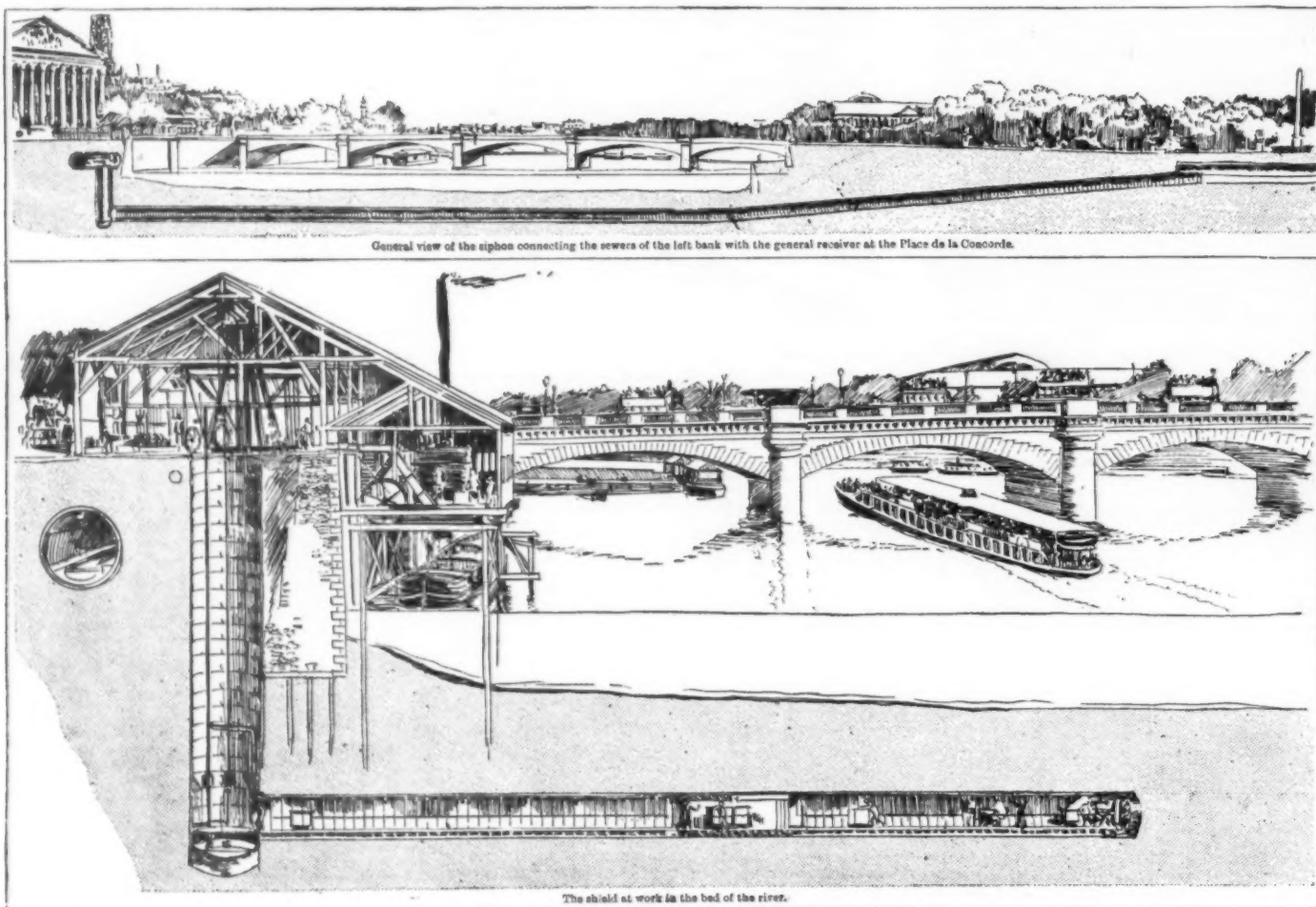
An effort was made to destroy the air that fed the flame, and through a drill hole lime and nitric acid and gas were forced down. At other times other gases were manufactured in retorts high up on the bleak mountain side and pumped down on the burning mass. It was all without apparent effect on the energy of the fire.

FINAL EFFORTS MADE.

The contest was waged thus until 1890, when, the burning area having been well defined on the surface, deep cuts were dug transversely to the vein on each side of the fire. The strata of rock, clay and slates covering the coal was stripped off, and the uncovered coal was taken out down to the bottom slate.

The coal saved by the stripping in the cuts was run down the mountain side by gravity, prepared for the New York market at the breaker of No. 5 colliery and sold to redeem in part the money so uselessly spent in this twenty years' war with an unseen but none the less destructive fire.

The final effort to quench it was the development of the most recent theory of the scientist. Fine culm coal dust washed with water will pack closer than clay. Six inch drill holes were driven down to the fire. Water was brought from a mile away in an oak plank flume. As the water rushed in the culm was fed with it so it should be spread through the burning cavity and fill it up and shut out the air. Into one of these drill holes, at the time of my visit, 1,054 carloads, a car containing six and a half tons of culm, had been



THE SEWERS OF PARIS—SECTIONAL VIEWS OF THE CONCORDE SIPHON NOW IN COURSE OF CONSTRUCTION.

At the foot of the new slope pumping and hoisting machinery was stationed. A handful of oily cotton waste, used about these engines, was dragged up the slope by rats and carried behind the timbers and into the crevices, where they had their nests. The oily waste ignited spontaneously and started the destruction which has cost a great fortune in cash and coal.

A cubic yard of coal in the vein weighs approximately a ton. The fire is now confined in a bed 2,000 feet long, about 30 feet thick and say 450 feet deep. A close estimate of the original quantity of fuel places it at 1,175,000 tons, from which deduct the little that "Jim" Andrews mined and a little more that may be saved eventually.

It is not in the length of time this fire has burned that it is unique. At East Pine Knot colliery, near Pottsville, an underground fire has raged for more than thirty years. At Wadesville, in the same neighborhood, a vein has burned for forty years. The latter vein crops out at the surface, and the fire frequently gives it a very volcanic appearance at night.

But in neither case, and they are cited only as examples of many, has there been anything like the amount of destruction nor has the fire shown such a stubborn resistance as this one at No. 6. In fact, in those cases the fire was just blocked off and allowed to burn away.

And there have been subsurface fires which had gained greater headway than that at No. 6 when discovered, and which were extinguished, some with loss of life, it is true, and after what seemed an extravagant outlay of money. But in this, too, they did not compare with No. 6. Some, being below water level, were simply drowned out, surface streams being turned into the mine until the water rose above the level of

needed air. Men were detailed to hunt such spots and quickly cover them with impervious clay to shut out the offending atmosphere.

MR. GALLAGHER'S STORY.

Neither Mr. Harris nor Mr. Radcliffe, the outside superintendent, would vouch for the story that Dennis Gallagher, one of the men thus employed, tells. Watching for the outcropping of gas and vapor and wheeling barrows of clay was rather monotonous and not overpaid work. Dennis' mind was more active than his feet, and the sulphur made his imagination lurid. Still the story may be true. He declared that the ground was so treacherous and liable to cave in over the fire that he carried a sixteen-foot board with him to wheel his barrow on. Of course, every sixteen feet he had to stand on the treacherous ground until he kicked the board ahead.

"Suddenly the ground went from under'n'ath me for fifteen feet around," he said. "The inds o' me board, fortunately, rested on aich side of the hole, but it tilted and threw me. I grabbed it goin' down and hung, and there I hung for tree-quarters of an hour wid hell's fires a roarin' and a blazin' below, and the sulphur that bad I river drew the breath of life wanst. How did I get out? Well, all I knows is that Providence and me own main strength did it."

A recent incident illustrates with what violence the pent up vapor and gas force their way to the surface. Some of the men were sent to the clay bank for material to stop a new manifestation. One had an iron drill which he thrust two or three times into the embankments, when suddenly there was an explosion, a rush of many strong winds that blew the men a

washed, and the effect seemed to be promising. There was nothing at all wrong with the theory.

The fire is in the mammoth vein, which here is thirty feet thick. It is sixteen hundred feet above the level of the sea and nearly three hundred feet above the Central Railroad of New Jersey. Other veins above and below the mammoth are being worked all up and down the valley.

"There is coal enough here for two hundred years," they say, and that covers the range and limit of most of us, so that the loss of a million tons or so really cuts no great figure in the final summing up.

THE SEWERS OF PARIS—A SIPHON UNDER THE SEINE.

A METALLIC siphon is being constructed under the Seine to connect the sewers of the left bank of the river with the general receiver beginning at the Place de la Concorde, and then following the Rue Royale, Boulevard Malesherbes, and Place Laborde, until it reaches Asnières, about a mile outside the western portion of the city, where the sewage is discharged into the river. The engineer charged with carrying out this important enterprise is M. Berlier, whose remarkable success in achieving a similar work at Clichy in 1894 was recognized by the minister of public works. At the inauguration ceremony M. Berlier was presented with the cross of the Legion of Honor, the minister at the same time thanking him in the name of the government for having in two years accomplished a gigantic task.

Four millions sterling has been set apart by the Ville de Paris for works ultimately destined to restore the water of the Seine to its pristine purity and to render

its shores habitable. If all goes well, the scheme will be realized in four years' time, and visitors at the 1900 Exhibition may yet hope to take pleasant water trips to Bougival and St. Germain without danger of asphyxiation.

The conditions imposed by the civil authorities were to the effect that the navigation of the Seine should not be for a moment interrupted, nor the street traffic impeded. So far M. Berlier has given complete satisfaction in these particulars. Not a cart or wagon is to be seen, and the earth and stones dug out are carried away in barges. The system employed is that of the bouclier, or shield, worked by hydraulic pressure—substantially the same as the Beach shield, used in building the St. Clair tunnel and other similar work. The metal tube forming the tunnel proper is composed of five pieces joined together to form the circumference of each segment. An outer coating of cement is injected from within through holes devised for the purpose. The interior is lined with bricks and cement. No wood is employed. The shaft leading to the tunnel is some twenty-five or twenty-six yards deep. A glance at the illustrations will show the sewer alongside. This will, of course, not be connected with the siphon until it is completed. The work is particularly onerous on account of the danger of inundation, and the density of the atmosphere produces a feeling of vertigo very trying to the human moles who burrow away in the bowels of the earth for six hours at a stretch. Needless to say, great care has to be exercised in choosing healthy subjects.

The really interesting part of the undertaking is when the boring of the tunnel begins. It is then that the famous shield (bouclier) comes into operation, pursuing its course with resistless force and method. It is a sheet iron cylinder of a diameter a trifle larger than the metal tubes that form the tunnel, resembling, for example, the outer and inner tubes of an opera glass. It is divided transversely into two parts. The portion in front is made to cut into the soil. A series of powerful hydraulic presses are disposed around the circumference of the rear, which, by being supported against the already finished part of the tunnel, are able to push on the whole apparatus in the required direction. The miners meanwhile are engaged in digging and carting away the debris to the shaft, where it is hauled up and thrown into the barges. Pick and shovel are generally sufficient to dislodge all impediments in front, but sometimes dynamite is employed. As the cylinder advances, another segment of tubing is added, the difference in the diameter allowing for the exterior coating of cement. Thus bit by bit the siphon is permanently fixed, and rendered impervious to earth slips or inundation.

When the Concorde siphon is an accomplished fact we may hope that the Chamber of Deputies will give its final sanction to the much talked of tubular electric tramway from the Bois de Vincennes to the Bois de Boulogne. If this is not taken in hand in time for the 1900 Exhibition, it will probably be relegated to the Greek Kalends. The length of the underground tubular line would be about eleven miles, with seventeen stations, embracing such populous centers as the Gare de Lyon, Place de la Bastille, Hôtel de Ville, Boulevard Sébastopol, Rue du Louvre, Palais Royal, Rue du Castiglione, Place de la Concorde, Rond Point, Avenue de l'Alma, Arc de Triomphe, Place Victor Hugo, and the Bois de Boulogne. For our illustration and the accompanying particulars we are indebted to the London Daily Graphic.

DEFENSES OF CONSTANTINOPLE.

Few places lend themselves so readily to the purposes of defense as the narrow straits that separate the Sea of Marmora from the Aegean, and it may be doubted if any coasts have greater historical associations than those opposite shores of Asia and of Europe that go by the name of the Dardanelles.

The military correspondent of the London Daily Graphic furnishes the accompanying map and highly interesting details of the forts and defenses which line the passage to Constantinople through the Dardanelles.

On either side of the narrow waterway Nature seems to have conspired to render difficult the passage of the invader. Nor has man been backward in assisting her designs. By the erection of works of defense along both shores he has endeavored to improve by art the natural capabilities of the place.

As we steam up the straits, associations teem on every side, and scarcely have we left the plains of Troy, stretching away on our right hand, when we pass the spot immortalized by Leander's feat, in later years repeated by Byron. Here the army of Alexander crossed from Europe to Asia; here the Crescent for the first time was borne into Europe; and a little further on Gallipoli, the chief town of the Thracian Chersonese, recalls memories reaching from the distant past down to recent times, when its occupation by the allied armies of France and England was the first step in the Crimean campaign. But if in old times the passage of the Dardanelles, that outwork of Constantinople, was hazardous, how much more so has it now become when modern guns and modern forts, to make no mention of such inventions as torpedoes and submarine mines, can render the picturesque and winding channel as dangerous and defensible a piece of water as any in the world.

As we pass into the channel the first signs of fortifications that meet our eye are the twin forts of Seddul-Bahr and Kum Kaleh, on the European and Asian coasts respectively, guarding the entrance of the passage, which here is some five miles broad. The old forts at these points are stone buildings, very much out of date now, and containing some ten or twelve Paixhan guns. New batteries have been erected near the old ones and mount ten Krupp guns on the Asian and four Krupps of 28 centimeters on the European shore. As we continue our way the channel widens considerably, before narrowing to its least width opposite the town of Chanak Kalesi, otherwise known as Dardanelles, from which the strait takes its name. This is the key of the whole passage, and the forts on either side at this point are shown in the accompanying map.

Here lie the chief works of the defense on either coast, which, by their mutual defense, if properly

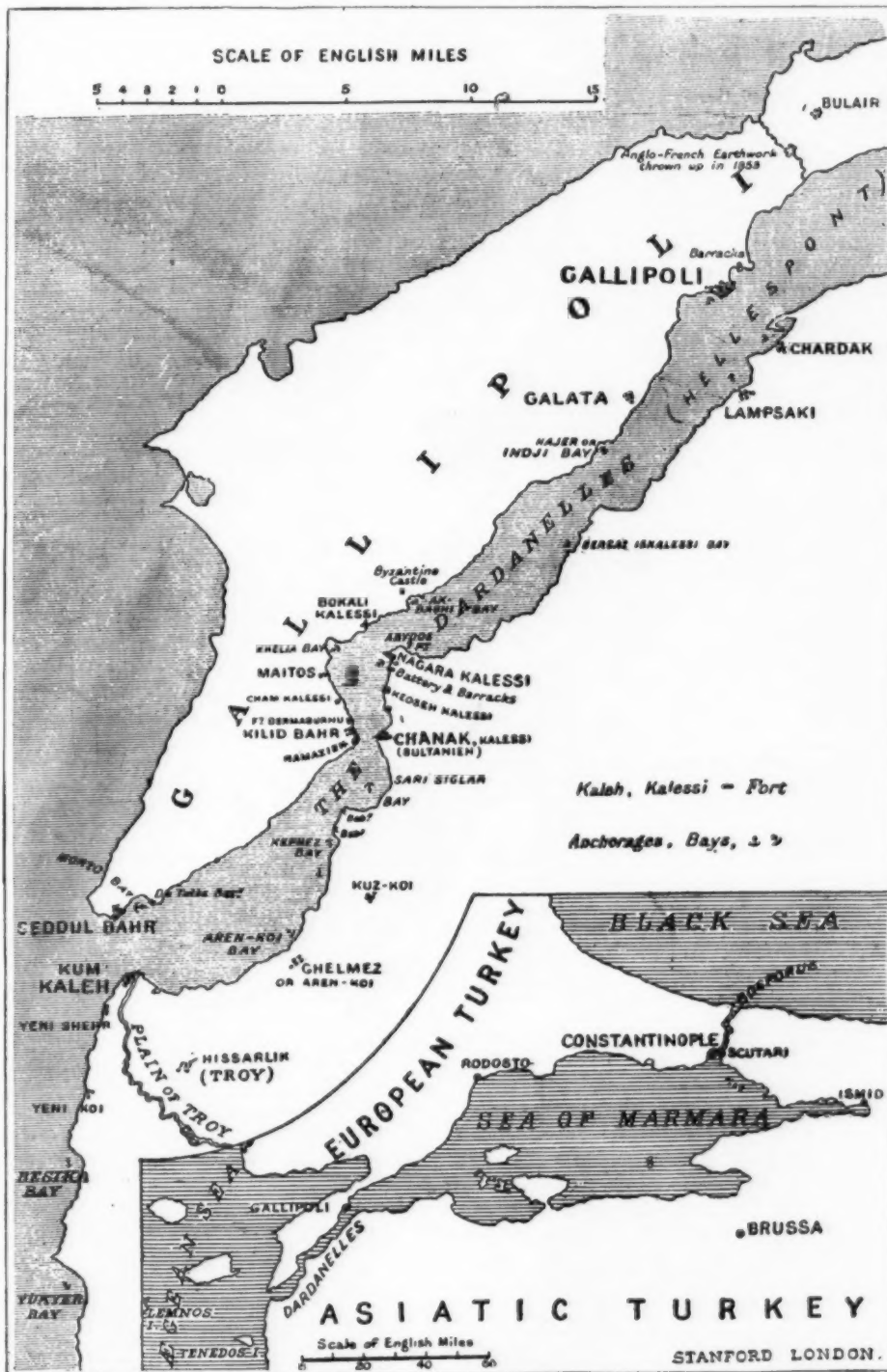
manned, will render a successful passage almost impossible.

On the right, or Asian side, rise the works of Chanak Kalesi, consisting of a main redan, mounting at least one Krupp gun of 35 centimeters and an earthwork, also armed with Krupps. Close to these modern works is an old stone castle possessing nine bronze guns, which with their stone shot are now more curious than effective. In the town itself, which is built on a flat point, and enjoys a considerable trade in wine and pottery, are some large military magazines and a military hospital.

On the opposite coast is the old fort of Kilid Bahr, at the foot of a steep hill, its towers overlooked by the new fort built on higher ground, and known by the name of Fort Namazieh, a recent work, and one of the greatest importance, both from its position and its armament, which consists of twenty-four Krupp guns of various calibers, the whole work being supported by three batteries, each mounting four guns. It is

manding the whole, and each mounting eight guns. This exhausts the lists of batteries, and it must be confessed that the array of works is a formidable one, and the muzzles of no fewer than sixty-seven Krupp guns on one side and forty-eight on the other, all bearing on the channel, render its successful passage enormously difficult.

Along each shore a good road connects the works, which are further united by a telegraph line. There is, however, one weak spot in the defense of the Dardanelles, which is the exposure to attack from the rear of the forts on the European side. An army covered by a sufficient fleet might, without much difficulty, land on the coast of the peninsula either in the Gulf of Saros or on the coast opposite the Isle of Imbos. Once established on the peninsula it would be an easy task to seize the earthworks on the European shore of the Dardanelles, the gorges of which are, as a rule, open, and offer little resistance to attack from the rear. With these commanding forts in his hands,



WATERWAYS TO CONSTANTINOPLE—THE DARDANELLES, ITS ANCHORAGES, BAYS, AND DEFENSES.

difficult to imagine any place more admirably suited for defense than is this exceedingly narrow part of the channel, commanded as it is by works armed with modern weapons, and to which an additional advantage is given by a turn in the channel which obliges advancing vessels to somewhat slacken speed when just opposite the forts. And once beyond this dangerous spot, success does not necessarily await the incoming ship, which still finds many forts, old and new, ready to open fire on it from either shore.

On the European side are the forts of Dermaburnu and Cham, the former new, the latter old, but with a newly erected earthwork in its vicinity; while further on lie the forts Maitos and Bokhali, and a battery at Khelia Tepe, all modern or modernized, and mounting modern guns. On the Asian shore, beyond Fort Chanak, we have Medjidieh Fort, with sixteen Krupp guns, and this is succeeded by Fort Keeseh, an old stone work, and then by the Nagara group, consisting of an old fort with thirty-seven guns, a new earthwork with eleven Krupps, and two new redoubts com-

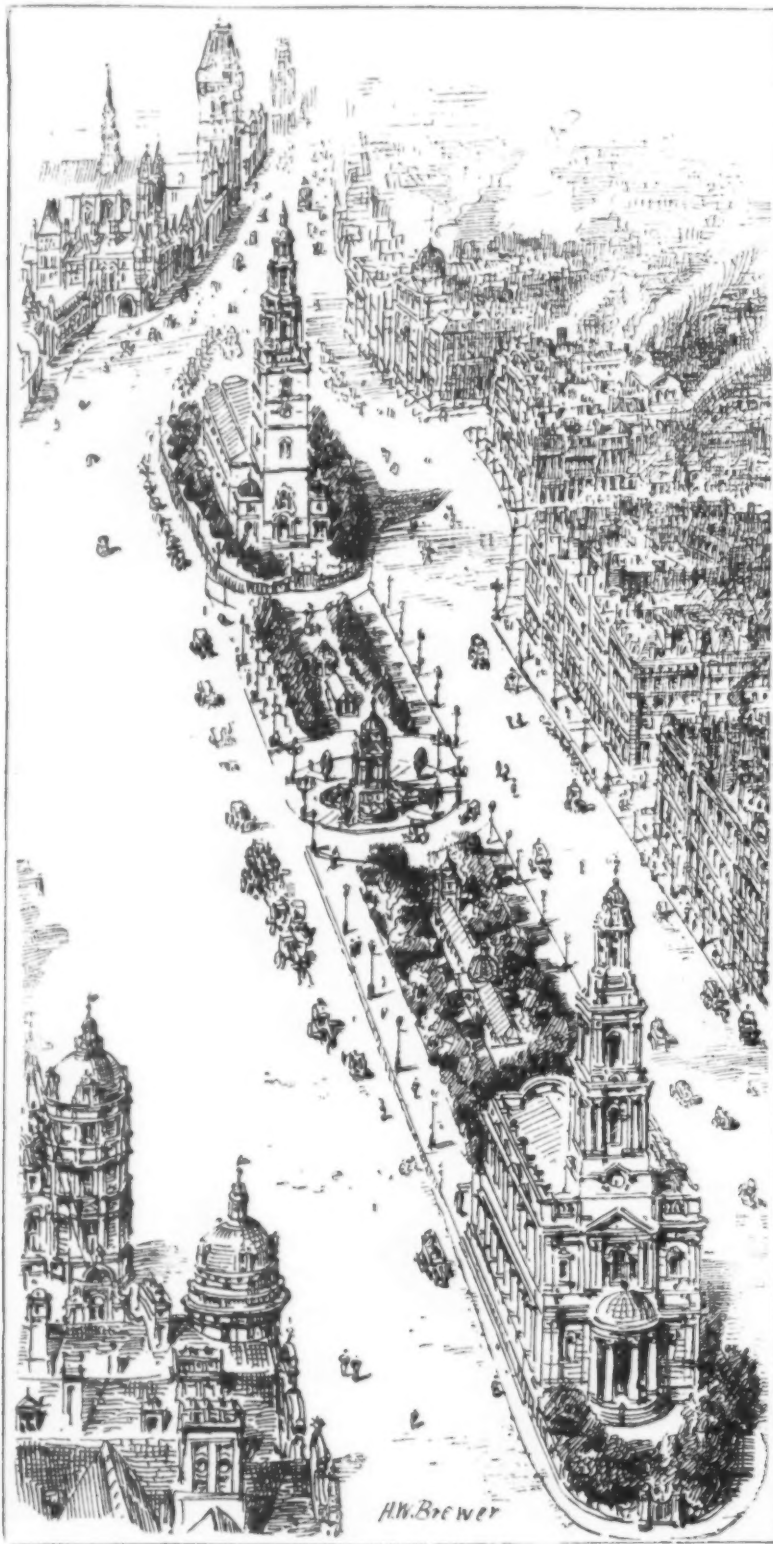
an enemy could subdue those on the opposite coast sufficiently to cover the passage of his fleet. Such, then, is a brief description of the defenses of the Dardanelles, comprising some forts whose strength has quite passed away, and others, placed generally on higher and more commanding ground, whose powers of resistance to an enemy's fleet advancing up the Dardanelles can, perhaps, scarcely be overestimated.

A METHOD of rendering water potable is said to have been devised by M. Allain, of Marseilles, who uses iodine in the proportion of one part in 100,000 to destroy bacilli, and then, after an interval of about twenty minutes, the free iodine is neutralized with sodium hyposulphite, and the water is filtered through animal charcoal or in the ordinary way. If the water is not very impure, this filtering is not necessary. It is stated that the water treated with iodine in this manner is colorless, odorless, and tasteless.

THE IMPROVEMENT OF LONDON.

AFTER the great fire of London in 1666, Sir Christopher Wren recognized the fact that London had a system of ill contrived streets and he attempted to remedy this by an elaborate series of streets which to-day would have made London one of the most beautiful and imposing cities of the world. Unfortunately, Parliament did not consider it advisable to adopt his plan, and the result is that the city was rebuilt on the old lines. For years Londoners have realized the expense and inconvenience occasioned by the daily congested traffic in central London, but as yet nothing has been done to provide a remedy. The old Metropolitan Board of Works gave London the splendid thorough-

curved in rehousing some 4,000 people belonging to the working class. No estimate of this supplementary expenditure has been given. We present a plan of this road showing a section of the city which it traverses and its feeders, and also a view showing the picturesque possibility of the so-called island in the Strand, which is at present bounded by the churches of St. Clement Danes and St. Mary-le-Strand. This would, without doubt, be a great improvement from an aesthetic point of view, but the enormous expense would make it almost impossible to be adopted. It is now universally agreed that something more is needed than the mere joining of such important thoroughfares as the Strand and Holborn. Southward, facilities must be provided for the traffic across the river

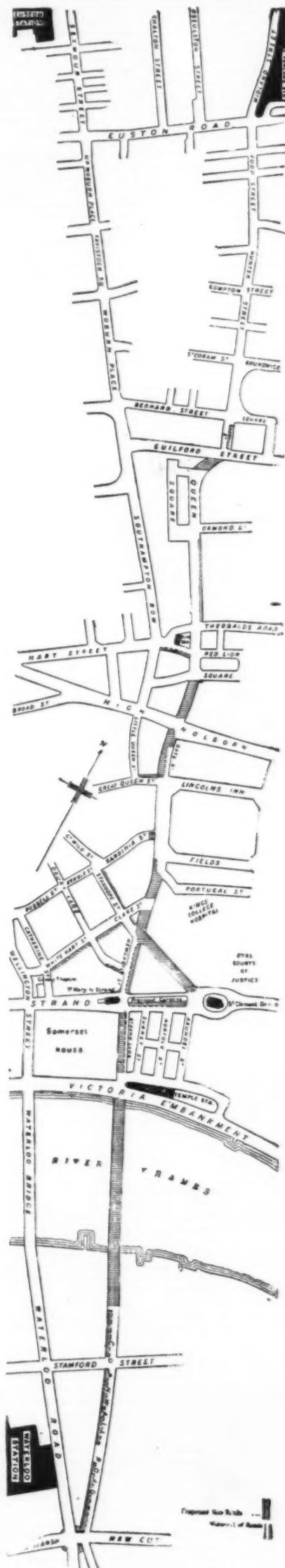


THE IMPROVEMENT OF LONDON—THE PICTURESQUE POSSIBILITIES OF THE ISLAND IN THE STRAND.

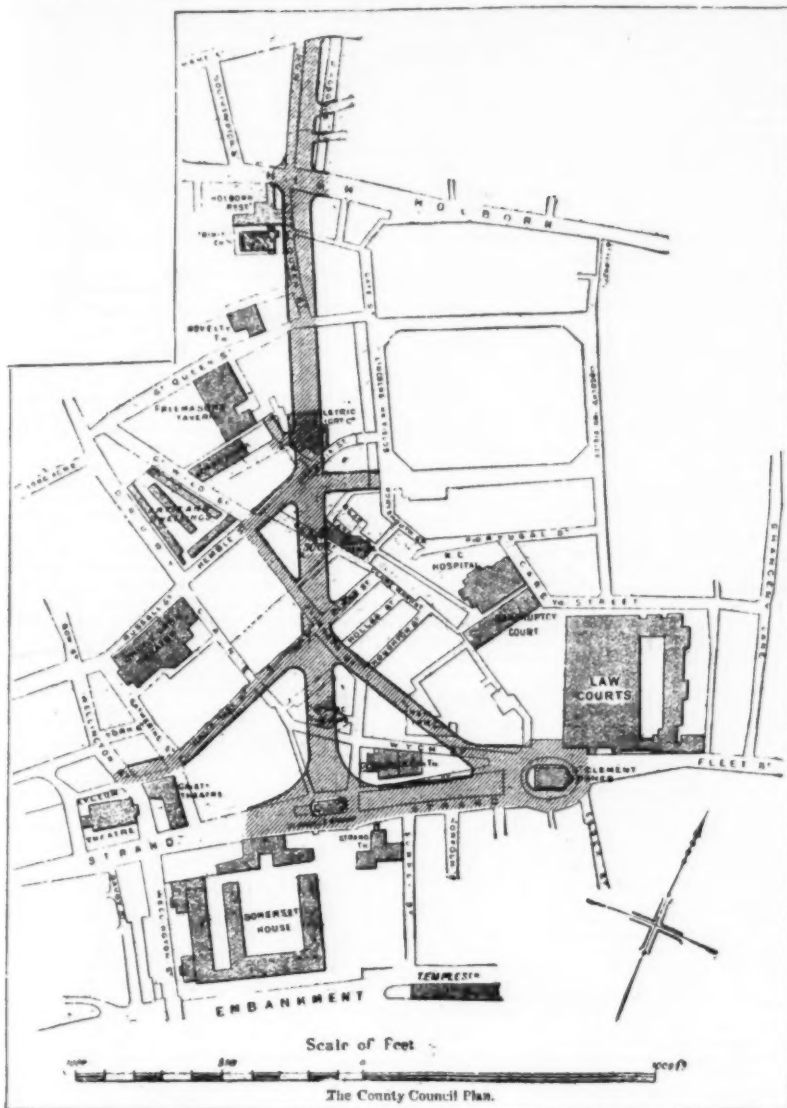
fares of the Thames Embankment, Northumberland Avenue, Charing Cross Road and Shaftesbury Avenue, but the County Council has as yet done nothing toward relieving central London. They have, however, brought forward several schemes for relieving the traffic. On one point everybody is agreed—that there ought to be additional means of communication between Holborn and the Strand. At present it is only possible to pass from one thoroughfare to the other by traversing a series of narrow streets and lanes. This plan of the County Council contemplates the construction of an entirely new street, 90 feet wide, running almost due south from the corner of Southampton Road and expanding as it nears the Strand into a wide mouth, of which the Church of St. Mary-le-Strand would form a delta, if it may be so called. The cost of this road is estimated to be about \$10,000,000. In addition considerable expenditure would have to be in-

and northward in order to reach the Great Northern Railway Termini. The improvement suggested by the London County Council assumes that the point to be aimed at is the Wellington Street end of Waterloo Bridge and suggests two alternate ways of getting to that point from the new road.

Traffic under these schemes may either follow the main road down to its junction to the Strand by St. Mary's Church, and thence continue westward along the Strand to Wellington Street, or it may shoot off at an angle, and, rounding the northwest corner of the Gaiety Theater, come out into Wellington Street opposite the Lyceum. Sir Whitaker Ellis, on the other hand, proposes to content himself, presumably for the sake of economy, with debouching into Catherine Street. This plan would have the effect of giving the traffic from Waterloo Bridge across the Strand an awkward diagonal twist, which is obviously much



Plan of a Proposed Route between Waterloo Station and St. Pancras, London.



THE PROPOSED IMPROVEMENT IN CENTRAL LONDON.

more difficult to regulate and more dangerous for foot passengers than the direct crossing of two lines of traffic at right angles.

Sir Whittaker Ellis, however, has an altogether independent plan for avoiding or diminishing the block

in the Strand. The block, he contends, is largely due to the fatal mistake of attempting to force through Wellington Street all the central London traffic that has to cross the river. What he proposes to do is to give access to Waterloo Bridge from the Embankment,

If it were possible, he argues, to get from the Embankment on to Waterloo Bridge, a great deal of the traffic which now goes along the Strand as the only means of reaching the bridge would be diverted. To carry out his project he proposes to build a roadway sloping up to the bridge on either side from the Embankment.

The sloping roads would start on the west side from a point close to Charing Cross pier, and on the east side from a point near the Temple pier. In order to make room for these new roads without encroaching on the Embankment roadway, it would be necessary to build out into the river.

We have next to consider the question of the route north of Holborn.

The improvements committee of the County Council has evidently acted on the assumption that the traffic must be turned into Southampton Row. But this thoroughfare, though most convenient for Euston, is very ill placed for the traffic to St. Pancras and King's Cross. Already, in fact, the omnibuses for these two stations leave Southampton Row at the earliest possible point, and turning eastward along Guilford Street, proceed by way of Brunswick Square, Hunter Street and Judd Street. The natural inference is that the connection wanted is a direct road from Holborn to the point where the line of Hunter Street crosses Guilford Street. Such a road can be made by continuing, almost in a straight line northward, the new road along the side of Lincoln's Inn Fields, proposed by Sir Whittaker Ellis. Crossing Holborn at its broadest part, just by the side of the Royal Music Hall, this road would skirt the west side of Red Lion Square, throwing off a short branch into Southampton Row, and enter Queen Square by way of Devonshire Street, a poor and dirty street which would have to be widened. In Queen Square the route would follow the roadway on the east side of the square, and so enter Guilford Street a few yards only to the west of the point aimed at. By following this route the necessity of widening Southampton Row, where the houses are extremely valuable, would be avoided, and—Southampton Row still remaining available—we should have two good routes instead of one to the northern terminus. In the accompanying plan this suggested route is shown as the natural continuation of Sir Whittaker Ellis' scheme, and of the proposed Temple Bridge. It will be observed that the route skirts no fewer than four open spaces—Lincoln's Inn Fields, Red Lion Square, Queen Square and Brunswick Square.

Among the other suggested improvements are the construction of the Boulevards along the line of the Euston and Marylebone Roads, at St. Paul's Church, and an improvement which is certainly needed at the junction of Newgate Street with St. Martin's-le-Grand and Cheapside, for at this corner there is a chronic block. The traffic coming from St. Martin's-le-Grand in trying to get southward by the narrow roadway of the east end of St. Paul's is interrupted by the stream of traffic from the Bank of England westward, and from the west to the bank. Newgate Street and Cheapside are not in a straight line, so that the east and the west stream does not cross the north and south stream at right angles. The expense of dealing with this most difficult corner would undoubtedly be enormous, but it is doubtful if the works which have been mentioned would be of as much real value as this one. To make the improvement complete, the narrow roadway, at the back of St. Paul's, should be widened and extended southward across Cannon Street into Queen Victoria Street.

Of course this improvement would add greatly to the appearance of St. Paul's Cathedral. We give an illustration of the proposed square between St. Martin's-le-Grand and St. Paul's. For our engravings and plans, as well as the foregoing particulars, we are indebted to the Daily Graphic. We have published this account of the proposed improvements to relieve the traffic in London, in view of the fact that a similar state of affairs exists in both New York City and Boston. For many years the congestion of traffic in the lower part of New York has seriously interfered with business, but the pressure of travel has been greatly relieved by the extension and widening of College Place, and will be still more relieved by the widening of Elm Street.

In Boston the expensive subway is now being built solely to admit of clearing the streets of cars, so as to allow for the ordinary traffic.

The widening of West Street, New York, has been going on for years and is about half finished. This is one of the most interesting engineering works which has been carried on in New York for several years.

Owing to the convergence of all the streets to the point at the end of Manhattan Island, the river front along the Hudson and all the main streets in the lower part of the city have been so congested that traffic has at times been almost impossible. Some years ago the work of building out the piers further into the river was undertaken with a view to constructing a sea wall so far beyond the old line of the old docks and piers as to enable the overcrowded West Street to be widened some hundred feet or more. The work is necessarily slow, and is very expensive, as so much of the work has to be carried on under water, and when the bulkhead is completed the space redeemed must be filled in with concrete and soil, after which the new superstructures are erected. Already the benefit derived from the changes is greatly felt, and commerce is no longer impeded as formerly.

[Continued from SUPPLEMENT, No. 1046, page 16724.]

NOTES ON GOLD MILLING IN CALIFORNIA.*

By ED. R. PRESTON.

No. 11. Placer County—The quartz carries but a small percentage of sulphurets, and is delivered from the mine over an incline tramway to two grizzlies with 12 bars, 3 in. apart, 12 ft. long, 3 in. deep, and $\frac{1}{2}$ in. wide, set on an angle of 45°. In front, below, and between the grizzlies is a Blake crusher, from which the ore drops into the bin that supplies the Challenge feeders. These are operated from the center stamp. The stamps weigh 750 lb. each, and drop 5 in., 90 times a minute, and the discharge averages 5 in. The screen is set on a 4 in. block, with a 5 in. plate on the inside.

* From Bulletin No. 6 of the California State Mining Bureau. J. J. Crawford, State Mineralogist.



THE IMPROVEMENT OF LONDON—PROPOSED SQUARE BETWEEN ST. MARTIN'S-LE-GRAND AND ST. PAUL'S.

The screen is a No. 10, slot-punched, set with a slight incline. Part of the water for the battery is supplied from a small wooden trough, pierced with holes, in front of the screen. The outside iron rim of the mortar is covered with a silvered plate. The apron, set on a grade of $1\frac{1}{2}$ in. to the foot, is 4 ft. long, and is followed by 12 ft. of sluice plates, 18 in. wide. After passing through a quicksilver trap, the pulp passes through a 3 in. pipe to the Frue vanners. A tank of quicksilver is used every three months, in crushing 3,500 tons of ore. The plates are scraped every day with rubbers, and are occasionally dressed with phosphate of lime, or with lye. The battery is cleaned out once a week, and yields 50 per cent. of the amalgam.

No. 12. Plumas County.—The ore is free milling, and contains about $1\frac{1}{2}$ per cent. of sulphurets. It is delivered to the Blake crushers in the mill by an incline-tramway, and the ore passes through the bins to the Challenge feeders. The stamps weigh 850 lb. each, dropping $8\frac{1}{2}$ in., 80 times per minute. The discharge varies from 6 in. to 8 in., through No. 8 diagonal-slot punched screens, with a discharging surface to each battery of 45 in. in length by 6 in. in height. The mortar is furnished with a lip plate and a cast iron trough, which receives the pulp, also with a 5 in. inside plate. The pulp passes from the trough to the apron and sluice plates, which have a grade of $1\frac{1}{2}$ in. to the foot and a length of 90 ft., and is then passed to the concentrators. Below the mill the tailings are picked up by outside parties and reground in arrastras. The tailings assay \$9 per ton. The loss of quicksilver at this mill is about a flask for every 4,000 tons crushed. The cost of milling does not exceed 50 cents per ton when using water power. The plates are cleaned every twenty-four hours. About 80 per cent. of the amalgam is derived from the batteries, which are cleaned up once a month. The headings are placed in an iron revolving barrel, and the panning out is done with a baten.

No. 13. Plumas County.—The ore is hauled to the mill by wagon, and is broken and fed by hand. The stamps weigh 750 lb. each, drop 5 in. to 6 in., 80 times per minute, with a discharge varying from 6 in. to 8 in., through a No. 9 slot-punched, Russian iron screen, crushing $1\frac{1}{2}$ tons per stamp per twenty-four hours. The battery is supplied with an inside plate, about 6 in. wide, attached to the screen; the latter is set slightly inclined. The screen frame leaves about 4 in. at the upper end of the mortar front open, in front of which and reaching nearly to the lip is a canvas curtain. The apron plate is 5 ft. \times 4 $\frac{1}{2}$ ft., set on a grade of 1 in. in 11 in.; below the apron is a drop box, from which the pulp passes to the sluice plates; these are 10 ft. long by 15 in. wide. The aprons are scraped every day with rubber belting, and the plate on the screen is cleaned once or twice a week. In dressing the plates, brine with an addition of sulphuric acid is used. About 20 per cent. of the amalgam is saved in the batteries, and about 80 per cent. on the plates. Neither concentrators nor canvas tables are used. One tank of quicksilver is used every six months, using twenty stamps.

No. 14. Shasta County.—The ore carries $1\frac{1}{2}$ per cent. of iron and copper sulphurets, besides free gold, averaging \$9 per ton. There are 30 stamps, weighing 850 lb. each, supplied with Challenge feeders, working from the second stamp. These stamps are hung and dropped somewhat at variance with the usual custom, No. 1, the end stamp on the left, being placed 1 in. farther from the side than is No. 3, the end stamp on the right, and the sequence of the drop is 5, 4, 3, 1, 2; the stamps never rising out of the water. It is claimed that by this arrangement a better swash is obtained in the battery. The stamps drop 5 in., 93 times per minute, with a discharge of 6 in. to 7 in., and crushing 9 tons per stamp per twenty-four hours. The mortar is supplied with front and back inside plates. The apron plate is 4 ft. \times 4 ft., set on a grade of $1\frac{1}{2}$ in. to the foot, followed by a double set of sluice plates, 16 in. wide and 16 ft. long, with a grade of 1 in. to the foot. The apron plate is kept rather wet with mercury by frequent dressing. Burr slot screens, Nos. 40 and 45, are used. About 66 per cent. of the amalgam is derived from the battery. The pulp is concentrated on four Triumph and ten Frue vanners, and is then passed to two canvas platforms, 36 ft. and 24 ft. long, respectively, and 20 ft. wide, divided into sections $2\frac{1}{2}$ ft. in width, covered with twill instead of canvas, which is said to give equally good results, and is considerably cheaper. These tables have a grade of $1\frac{1}{2}$ in. to the foot. The plates are scraped once a day, and the mill is cleaned up twice a month. The company chlorinate their own sulphurets, roasting in a small two-hearth furnace, with a capacity of one ton per twenty-four hours.

No. 15. Sierra County.—On account of topography, the ore has to be elevated by a lift to the top of the mill. The stamps weigh 850 lb. each, and drop 5 in., 80 times per minute, with a 6 in. discharge through No. 7 slot-cut screens. The cams, bosses, and tappets are steel; the shoes and dies iron. The apron is 4 ft. \times 4 ft., with a grade of $1\frac{1}{2}$ in. to the foot, and is followed by a double sluice plate, 16 in. wide, 12 ft. long, and pitched $1\frac{1}{2}$ in. to the foot. The plates are not scraped at regular intervals; in dressing them, lye is used occasionally. The plate on the screen, 6 in. \times 52 in., is cleaned every other day. About 86 per cent. of the amalgam is saved in the battery, and the tailings only show a trace of gold. Johnston concentrators receive the pulp from the plates; these concentrators are run with 110 to 112 side strokes per minute, the belt revolving once in seven minutes. The waste from the concentrators is forced to a higher level by an "ejector," and then passes through a pointed box. The heavy material is then passed through a series of drop boxes and discharged into the river.

No. 16. Sierra County.—The ore carries a considerable amount of clay, and is delivered to the mill over an incline track to a Blake crusher. The stamps weigh 850 lb. each, and make 75 to 78 drops of 6 in. per minute, with a discharge varying from 7 in. to 9 in., using a No. 10 slot-cut screen. The inside of the mortar is furnished with front and back plates, the former 8 in., the latter 4 in. wide. Cast iron shoes and dies are used, crushing $1\frac{1}{2}$ tons to the stamp per day. The order in which the stamps drop is 1, 5, 2, 4, 3. The apron plate is the width of the mortar, is 6 ft. long, and is set to a grade of $2\frac{1}{2}$ in. to the foot, followed by 12 ft. of sluice plates, 14 in. wide. As there are but

few sulphurets, no concentrators are in the mill. The apron and sluices are dressed every day, but only scraped once a month; granide of potassium is used in dressing the plates. The battery is cleaned once a month. About 5 lb. of quicksilver is used to every 1,500 tons. About 70 per cent. of the amalgam is obtained from the battery.

No. 17. Tuolumne County.—This mill of 10 stamps crushes quartz containing little or no free gold, but with 3 per cent. of sulphurets, chiefly iron. The stamps weigh 1,000 lb. each (fed by self-feeders), working at 96 drops of 6 in., crushing $2\frac{1}{2}$ tons per stamp. Chrome steel shoes and dies are used, which wear about 1 in. per week. No. 20 brass wire screens are used, the screen having a slight inclination, 10° . There are no plates used on the inside of the battery, and only one apron plate, $4\frac{1}{2}$ ft. \times 6 ft.; to each five stamps, which is dressed daily. It is set to a grade of $1\frac{1}{2}$ in. to the foot. Nearly all of the amalgam is derived from this apron. The pulp passes from the aprons through a series of troughs to four Frue concentrators with corrugated belts, using a large amount of water. These are succeeded by wooden troughs, 8 in. wide at top, spreading to 16 in., which divide into three troughs, carrying equal amounts of pulp, thinned by adding 3 miner's inches of clear water above the forks. These deliver into a V-trough running at the head of a canvas platform, divided into twelve sections, 22 in. wide and 75 ft. long, set on a grade of $1\frac{1}{2}$ in. to the foot. These tables are covered with No. 7 duck, which lasts 90 days. The V-trough has extending over its entire length a square 8 in. trough, for clear water. The pulp flows from the V-trough through 1 in. auger holes (two to each section of the canvas), supplied with wooden plugs to regulate the flow of the pulp, the clear water trough being similarly supplied. Every half hour the flow of the pulp is arrested on a section, while the flow of clear water is

The ore is delivered from the mine at the top of the mill, into a general ore bin, for the entire 40 stamps, after passing through the rock breaker. The bin has a capacity of 850 tons, and delivers the ore into the self-feeders direct. The stamps weigh 850 lb. each, and steel shoes and dies are used. Each stamp has its separate guide, made of two blocks of hard maple, fitted together and bored through to receive the stem. The front block is first put in place, the stem set in; and the rear block dropped in behind a cast iron piece, which is secured by wooden wedges driven in from

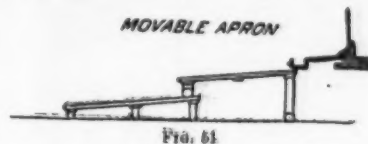


FIG. 51

above, so that when required it can easily be removed. The pulp from the battery falls over a 9 in. silvered plate, the width of the mortar, into a box 12 in. square, supplied with six 1 in. holes, 8 in. apart, near the front lower edge, that permit the pulp to flow onto a 4 ft. \times 5 ft. silvered plate, divided in two parts by a wooden strip down the center. The fall from the box to the plate is $3\frac{1}{2}$ in. The apron plate is mounted on a carriage, which can be pushed back, giving access to the battery, the 4 in. grooved wheels in front running on a half round iron strip placed on the sides of the lower plate frame. From the movable apron the pulp passes over 12 ft. of plates, divided into three 4 ft. sections, with a dividing strip down the center. Sixteen concentrators are used.

No. 19. Tuolumne County.—This mill presents some

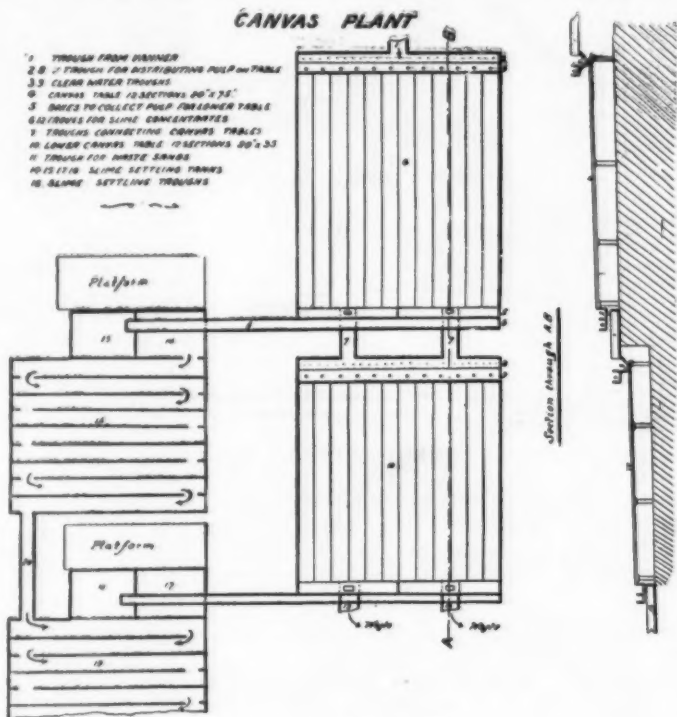


FIG. 50.

continued until the lighter sands are washed off, leaving the sulphurets on the canvas. The flow from the tables is delivered into V-boxes running across the end of the canvas platform, with a grade from the outer edges to the center, and delivered to a second canvas table trough, where it undergoes a similar treatment. After removing the lighter sands from the upper platform, a sheet iron pan is placed below the end, which extends to a separate trough, into which the sulphurets adhering to the canvas are swept with the aid of the flowing clear water, and conveyed to a settling tank divided into two sections in such a way that when one section is filled, the sulphurets are run into the second section, allowing the first to be shoveled out, each section being treated consecutively. When No. 1 is being swept, No. 2 has the pulp flow shut off, making the operation continuous. After sweeping down a section, the plugs from the pulp trough are removed and the clear water shut off, permitting the concentration to be renewed. It requires the attention of two persons, night and day, to attend to these two platforms. Everything but the sweepings pass over the second canvas platform, and then go to waste. The sweepings from the second table are treated in a manner similar to those from the upper one. Accessory to these two sulphuret settling tanks are two large slime settling tanks; these are divided into twenty sections, 2 ft. square, 20 ft. long, divided from each other by 2 in. plank extending entirely across the tank. Within 2 ft. of the ends, on alternate sides of these divisions, slots 4 in. deep and 2 ft. wide are cut to permit the water, which is clouded with the fine slimes, to pass from one division to the other. At the end farthest from the entrance, the water (still somewhat clouded) runs to waste. The slime water from the first settling tank passes through the second. The sulphuret settling tanks are shoveled out every few days, while the slime settling tanks remain undisturbed for months. The material from the vanners, upper and lower settling tanks, and sometimes from the slimes, is mixed by weight before going to the chlorination works. There are 2,400 sq. ft. of canvas tables and 5,000 sq. ft. of settling floor.

No. 18. Tuolumne County.—This mill is working on quartz carrying both free gold and sulphurets.

peculiarities in its construction. There are 10 stamps of 850 lb. each, with steel shoes and dies. The stamps are given 100 drops per minute, dropping $4\frac{1}{2}$ in., with only $2\frac{1}{2}$ in. discharge to commence on, through a No. 50 brass wire screen. The rock breaker (Wheeler pattern) and ore bin are set on a rock foundation, the frames being entirely disconnected from the rest of the building, to counteract the vibratory motion of the crusher. In placing the mortar block and mortar, the space around the block was filled with concrete, and a double thickness of tanned belting laid between the block and the mortar, after which a fire was built in the latter until it settled into the belting. The wear of the shoes and dies is about 1 in. per month, and the duty of the stamps $1\frac{1}{2}$ tons per stamp. When the dies are partially worn, a 2 in. iron plate is placed under them, to maintain a regular discharge. The inside of each mortar is provided with cast iron side plates and a sheet iron covered board at the back, to prevent wear on the mortar. The apron plates are set 12 in. out from the mortar. The pulp from the battery passes over a 9 in. plate into double pointed boxes of iron, bolted on the front of the mortar, and thence through a couple of 2 ft. pipes to a spreader and to the silver plated apron. The apron is followed by double sluice plates, each 2 ft. wide and 10 ft. long, all set on a grade of $1\frac{1}{2}$ in. to the foot. Two-thirds of the amalgam is obtained from the battery. No concentrators are used.

SPECIFICATIONS FOR A FORTY-STAMP GOLD MILL (WATER POWER).*

MACHINERY.

Water Wheels and Pulleys.—One water wheel, 6 ft. in diameter, to drive the battery; the wheel to be supplied with a shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 36 in. in diameter, grooved for $1\frac{1}{2}$ in. manila ropes. One driving pulley, 12 ft. in diameter. One idler pulley, 48 in. in diameter, grooved for one $1\frac{1}{2}$ in. rope, and fitted with shaft and boxes. One slack tightener pulley 48 in. in diameter grooved

* From the VIIIth Report of State Mineralogist, 1888, p. 738.

for one 1½ in. rope, and fitted with shaft, boxes, carriage, track, and counterbalance weight.

The rope for transmission is to be put on in one piece, passing around the idler and slack tightener (which are to be set on an angle in such a way that they will take the rope from one side of one of the main pulleys and pass it on to the opposite side of the other pulley), thereby making but one splice in the whole rope, which will be kept in constant tension by the slack tightener.

One wheel, 4 ft. in diameter, to drive the rock breakers; the wheel to be supplied with a shaft, boxes, collars, gate, and nozzle, and a pulley 34 in. in diameter, grooved for one 1½ in. manila rope.

One driving pulley, 60 in. in diameter.

One idler pulley, 60 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft and boxes.

One slack tightener pulley, 30 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft, boxes, carriage, track and counterbalance weight; rope to be put on similar to that for the battery.

One wheel, 36 in. in diameter, to drive the concentrators; the wheel to be supplied with shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 16 in. in diameter, grooved for one 1 in. manila rope.

One driving pulley, 48 in. in diameter.

Forty Stamp Battery. Stamps to weigh 850 to 900 lb. each, arranged to run in eight batteries of five stamps each, by belts and friction clutch pulleys from battery line shaft.

Eight high cast iron mortars, single discharge, each to weigh about 5,000 lb.; to be planed all over the bottom, and faced where the apron joins on; eight holes to be accurately bored in the base for 1½ in. anchor bolts. Each mortar to have five cast iron linings. The aggregate weight of these linings is about 500 lb. per mortar.

Eight cast iron aprons, to be faced where they join on to the mortars, and fastened in place with ¾ in. bolts.

Eight sugar pine screen frames, to have iron facings put on the ends where the keys bear against them; the edges to be fitted with dowel pins to join them to the inside plate block.

Sixteen inside plate blocks, two sets, one to be 6 in. high and the other to be 4 in. high; to be well fitted into the mortars, and to have plates fitted and fastened on with brass screws; blocks to be bolted together to keep them from splitting, and to be fitted with iron facings where the keys bear against them, and well fitted to the screw frames.

Eight brass wire screens, No. 30 mesh, to be fastened on to the screw frames with copper tacks.

Sixteen gilt headed end keys, for screen frames, to be well fitted in place.

Sixteen bottom keys, for screen frames, to be well fitted in place.

Sixty-four foundation bolts, for mortars, to be 1½ in. in diameter by 30 in. long, with hexagon nuts on the top ends and steel keys in the bottom ends.

Sixty-four wrought iron washers, 4 in. × 4 in. × ¾ in., for bottom ends of foundation bolts.

Eight sheets of rubber, ¼ in. thick by 30 in. by 60 in., for mortar foundation. Mill blankets tarred may be used in place of rubber.

Forty chrome steel or cast iron dies, 9 in. in diameter by 7 in. high, with square base well fitted into the mortars, 10 in. from center to center.

Forty chrome steel shoes, 9 in. in diameter by 8 in. high, with tapered shank 3½ in. in diameter at top end, 4½ in. in diameter at bottom end, by 5 in. long, to fit into the stamp heads by being covered with dry hard pine, ¾ in. thick; this being driven in by being allowed to drop a few times on the bare die.

Forty chrome steel stamp heads, 9 in. in diameter by 17 in. long, with a conical socket cored into the lower end, 4 in. in diameter at inner end and 5½ in. in diameter at the outer end, and 5½ in. deep, and a conical socket cored and actually bored out to fit the tapered end of the stamp stem, 2½ in. in diameter at inner end and 3½ in. in diameter at the outer end, by 6 in. deep. Transverse rectangular keyways are to be cored through the stem head, 1 in. × 2½ in., for loosening the shoes and stems.

Two steel loosening keys, ¾ in. thick, by 1 in. at the point (3 in. at the head) by 18 in. long, for loosening the shoes and stems.

Forty best refined iron or mild steel stems, turned perfectly true, full length, 3¼ in. gage by 14 ft. long, to be tapered on both ends to accurately fit the stamp heads. Each stem weighs about 300 lb.

Forty chrome steel, double faced tappets, 9 in. in diameter by 11 in. long, with a steel gib and two steel keys accurately fitted in place; both faces to be turned true; tappets to be bored with the gibs in place to accurately fit the stems, and to be counterbored opposite the gibs by moving the center ¼ in. away and, with diameter 1½ in. less than the bore, taking a cut ½ in. deep. Each tappet weighs 112 lb.

Eight upper and eight lower guides, with cast iron frames; guide blocks to be made of good, dry maple timber and well fitted in place; the guides may also be made entirely of wood.

Four extra quality, mild steel cam shafts, turned true full length, 5½ in. gage diameter by 14 ft. long; key seated for cam and pulley; key seats must not run through the bearings.

Ten heavy corner boxes, 5½ in. gage bore; eight of them to be 12 in. long and two to be 20 in. long; all of them to be planed all over the bottoms and backs, and furnished with bolts 1 in. in diameter, to fasten them to the battery frame.

Forty double armed, chrome steel cams—twenty right and twenty left hand—to be made 20 in. long over all, the hub to be 11 in. in diameter and 5½ in. through the bore; the lifting faces to be 2½ in. wide, and ground smooth; the hubs to be bored to fit the shaft accurately and properly key seated and fitted with steel keys, and each marked to their respective places, giving them a combination as follows:

Counting from the left hand side, when facing the battery, throughout the full ten stamps of each cam shaft, No. 1 cam will drop its stamp first; then Nos. 8, 4, 10, 2, 7, 5, 9, 3 and 6 consecutively.

This is the order: 1, 4, 2, 5, 3. Each cam weighs about 138 lb. The curve of the face of the cam is the involute of a circle, usually slightly modified.

Four pairs of cast iron double sleeve flanges, for

wood pulleys; flanges to be 36 in. in diameter, and 14 in. through the bore; to be turned all over the inside where they fit on the wood; the outside flange is to be bored and fitted to the sleeve and fastened with a gib headed steel key; the hub to be bored and fitted to the cam shaft and fastened with a steel key.

Four wood pulleys 22 in. in diameter by 17 in. face; to be made of best kiln dried sugar pine, and all joints to be filled with white lead in oil; the cast iron flanges to be well fitted on and bolted with twelve ¾ in. bolts.

Eight wrought iron collars, for cam shaft, 5½ in. bore, fitted with two steel set screws in each.

Eight wrought iron jack shafts 3 in. in diameter by 60 in. long; black finish.

Sixteen cast iron jack shaft side brackets, with four lag screws ¾ in. by 6 in. for each, to fasten them in place.

Forty open latch sockets lined with leather.

Forty wood finger bars, to be fitted and bolted to the above sockets, and furnished with wrought iron caps and handles.

A complete set of water pipes for a battery of forty stamps, with all fittings, cocks and connections.

Bolts and Washers for Battery Frame.—Six brace rods, 1¼ in. by 25 ft., 7 in. between two nuts; 6 brace rods, 1¼ in. by 13 ft., 8 in. between two nuts; 26 bolts for mudsills, 1 in. by 30 in.; 24 bolts for yokes, 1 in. by 28 in.; 24 bolts for yokes, 1 in. by 52 in.; 48 bolts for guide girts, 1 in. by 30 in.; 4 bolts for knee beam, 1 in. by 28 in.; 36 splice bolts for mudsills, ¾ in., 16 in. between head and nut; 12 splice bolts for tail girt, ¾ in., 2½ in. between head and nut; 32 bolts for mortar blocks, 1 in., 50 in. from point to point; 64 bolts for mortar blocks, 1 in., 65 in. from point to point; 24 joint bolts for posts, 1 in., 35 in. between two nuts; 6 joint bolts for knee posts, 1 in., 45 in. between two nuts; 6 joint bolts for knee posts, 1 in., 35 in. between two nuts; 24 joint bolts for knee beams, 1 in., 49 in. between two nuts; 10 joint bolts for tail girts, 1 in., 21 in. between two nuts; 24 cast iron washers for 1¼ in. rods; 514 cast iron washers for 1 in. bolts; 72 cast iron washers for ¾ in. bolts; 24 cast iron washers for ½ in. bolts; 40 sheet iron washers, 3½ in. square by ¼ in. thick, for 1 in. joint bolts.

Battery Line Shafting and Pulleys.—One shaft, 5½ in. gage by 18 ft. long, properly key seated; one shaft, 5 in. gage by 15 ft. 6 in. long, properly key seated; one shaft, 5 in. gage by 17 ft. long, properly key seated; one shaft, 4 in. gage by 17 ft. long, properly key seated; two shafts, 3 in. gage by 10 ft. 6 in. long, properly key seated; two face couplings, 5 in. gage, properly fitted and keyed in place; one face coupling, 4 in. gage, properly fitted and keyed in place; two face couplings, 3 in. gage, properly fitted and keyed in place; two babbitted boxes, 5½ in. gage; three babbitted boxes, 5 in. gage; two babbitted boxes, 4 in. gage; two babbitted boxes, 3 in. gage; all of the above boxes to be made of the same height, planed all over the bottoms, with drip cups cast on to the sides, and furnished with suitable bolts to fasten them to the 16 in. battery knee beams; two collars for 5½ in. shafting, with two steel set screws in each; four friction clutch pulleys, 48 in. in diameter and 16½ in. face, complete, with levers and connections; pulleys to be fitted to line shaft in their proper places, with phosphor-bronze bushings, the drivers to be properly keyed on with steel keys; one pulley, 6 ft. in diameter, grooved for three 1½ in. manila ropes, pulley to be well balanced and keyed to the shaft with a steel key.

Water Pipes.—Sufficient 3 in. pipes and fittings to connect battery pipes with feed water tanks.

Traveling Hoist.—One traveling crab with track iron and rails, to extend full length of battery.

One 2-ton Weston's differential chain block.

One Feeder.—Eight Challenge self-feeders, complete for batteries with all connections.

One Bin Gates.—Eight one bin gates, 18 in. by 24 in., for fine ore, with guides, racks, pinions, shafts, boxes, hand wheels and bolts.

Three one bin gates, 24 in. by 36 in., for coarse ore, with guides, racks, pinions, shafts, boxes, hand wheels and bolts.

Sluices and Aprons.—Eight cast iron aprons, 54 in. wide by 56 in. long, to be fitted under the lip of the mortar apron.

Eight silver plated copper plates, 54 in. by 56 in. by ¼ in., to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the cast iron aprons and fastened by strips of wood on the sides, which are bolted to the sides of the apron.

Eight cast iron sluices, 54 in. wide by 12 ft. long, to be made into two sections and bolted together by flanges, the lower section to have a quicksilver trap or trough cast on to the end, extending the full width of the sluice, and to have a connection made for a 2 in. pipe to conduct the pulp to the dividing tanks and thence to the concentrators.

Twenty-four silver plated copper plates, 54 in. by 48 in. by ¼ in., to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the sluices, overlapping at the joints, and to be fastened in place in the same manner as those in the apron.

There are to be eight silver plated copper shaking tables, one for each battery, placed below the apron plates. These tables consist of a light iron framework suspended upon movable springs. This table is given a longitudinal oscillation, by means of eccentrics.

Dividing Tanks and Pulp Pipes.—Eight cast iron dividing tanks, 10 in. long by 8 in. wide by 6 in. deep, with 2 in. pipe connection in one end and two 1½ in. pipe connections in the other end, each to have a wooden swinging tongue put in so as to direct the pulp to either of the 1½ in. pipes, or a part to the one and a part to the other. The tanks are to be connected with the sluices by 2 in. pipes, and with the concentrators by 1½ in. pipes.

Inside Plates and Blocks.—Three wooden blocks for each mortar, to be 3 in., 4½ in. and 6 in. high, respectively, to be fitted into the mortars under the screw frames; each block to have iron facings, fitted in flush and screwed on where the keys come and to have a silver plated copper plate bent to the proper shape and screwed on with silver plated brass screws; the copper plates to be made of best Lake Superior copper, 6 in. by 50 in. by ¼ in. and to have one ounce of silver per square foot.

Concentrators and Shafting.—Sixteen endless belt concentrators, complete, with water pipes and fittings to connect with supply tanks. All sulphuret tanks, complete, to be made of good redwood lumber.

One piece of shafting, 2½ in. by 16 ft.; six pieces of shafting, 2 in. by 16 ft.; three pieces of shafting, 2 in. by 10 ft.; eight face couplings, 2 in.; four babbitted boxes, 2½ in., with bolts for 8 ft. timber; eighteen babbitted boxes, 2 in., with bolts for 8 in. timber; two collars, 2½ in.; with steel set screws; two collars, 2 in., with steel set screws; one pulley, 48 in. in diameter, grooved for one 1 in. rope and properly fitted and keyed with a steel key to 2½ in. shaft; two pulleys, 6 in. face by 36 in. in diameter, properly fitted and keyed with steel keys to the 2 in. shaft; sixteen pulleys, 4 in. face by 10 in. in diameter, properly fitted and keyed with steel keys to the 2 in. shaft; sixteen loose pulleys, 4 in. face by 10 in. in diameter, properly fitted to the 2 in. shaft; sixteen collars, with steel set screws for same.

Rock Breakers and Shafting.—Two rock breakers, 6 in. by 15 in.; one piece shafting, 4 in. by 16 ft.; one piece shafting, 3½ in. by 16 ft.; one face coupling, 3½ in.; one face coupling, 3 in.; three babbitted boxes, 4 in., with bolts for 10 in. timber; two babbitted boxes, 3½ in., with bolts for 10 in. timber; two babbitted boxes, 3 in., with bolts for 10 in. timber; two collars, 4 in., with steel set screws; one pulley, 48 in. in diameter, grooved for 1 in. and 1½ in. manila rope, and properly fitted and keyed to the 4 in. shaft, with a steel key; three pulleys, 30 in. straight face by 20 in. in diameter, properly fitted and keyed to the shafting.

Clean-up Barrel.—One clean-up barrel, 24 in. inside diameter by 43 in. inside length, to be made of cast iron 1½ in. thick, with two discharge openings, 5½ in. in diameter, in the sides diametrically opposite each other, the heads and discharge doors to be accurately fitted; journals to be 4 in. gage, cast on to the heads; one tight and one loose pulley, 7 in. face by 30 in. in diameter; two babbitted boxes, 4 in. gage; one driving pulley, 6 in. in diameter by 14 in. face.

Batea.—One batea, 48 in. in diameter, with gears and hangers complete, and tight and loose pulleys, 4½ in. face by 16 in. in diameter; one driving pulley, 9 in. face by 21 in. in diameter.

Machinery for Clean-up Room.—One clean-up pan, 24 in. inside diameter, with tight and loose pulleys.

One driving pulley, 8 in. face by 16 in. in diameter.

One cast iron washing tank, 24 in. by 30 in. by 24 in. deep, with three pipe connections for drawing off water.

One cast iron washing tank, 30 in. by 36 in. by 24 in. deep, with three pipe connections for drawing off water.

One cast iron washing tank, 30 in. by 54 in. by 30 in. deep, with three pipe connections for drawing off water.

One marble top, complete, for washing tanks.

One side wash-stand, with pipes and fittings.

All pipes and fittings necessary to bring water to the clean-up pan and washing tanks.

Retort and Melting Furnace.—One retort, 10 in. by 36 in., inside dimensions, with amalgam trays, condenser, catch tank, furnace front, bearers, bars, smokestack and base plate, gey rods, dampers, binders and all pipes and fittings to bring water to the condenser.

One cast iron melting furnace, complete, with doors, grate bars, bearers, cast iron shell and damper.

Two bullion moulds for 500 and 750 ounces.

Four black lead crucibles, No. 16, with covers.

One crucible tongs for No. 16 crucible.

One skimmer for bullion.

Transmission Ropes and Belts.—Six hundred feet best manila or cotton rope, 1½ in. diameter, to drive battery line shaft.

Two hundred and fifty feet best manila rope, 1½ in. in diameter, to drive rock breaker line shaft.

One hundred and fifty feet best manila rope, 1 in. in diameter, to drive concentrator line shaft.

Two hundred feet best rubber belting, 16 in. by 5 ply, for batteries.

One hundred and eighty feet best rubber belting, 10 in. by 4 ply, for rock breakers.

Thirty-two feet best rubber belting, 7 in. by 4 ply, for clean-up barrel.

Sixty-five feet best rubber belting, 6 in. by 4 ply, for batea.

Thirty feet best rubber belting, 6 in. by 4 ply, for concentrator shafting.

Four hundred and twenty feet best rubber belting, 3 in. by 4 ply, for concentrators.

Thirty feet best rubber belting, 3 in. by 4 ply, for clean-up pan.

BUILDINGS AND ERECTION OF MILL, ETC.

Stonework.—All foundations and retaining walls to be built of large stone, properly banded and well laid in cement mortar, composed of ten parts good, clear sand, two parts good quality of lime, and one part best Portland cement, special care being taken to keep all dirt or clayey material excluded; all exposed faces of retaining walls to be well pointed up and finished with the same material.

One Bins.—Mudsills to be made of 12 in. by 14 in. timbers, laid flatwise; foundation posts to be made of 14 in. by 14 in. timbers; sills, posts and caps for ore bins proper to be made of 12 in. by 12 in. timbers, the posts to be boxed 1 in. into the sills and caps; braces for incline bottom to be made of 10 in. by 12 in. timbers, supporting braces to be made of 8 in. by 12 in. timbers. All planking to be 3 in. thick and lined throughout with 1 in. boards, to break joints over the planks.

Battery Frame.—Mudsills to be made of 14 in. × 16 in. sugar pine, or good yellow pine free from sap; to be well bedded in concrete, which must be put on the clean bedrock. Linesills to be made of 12 in. × 16 in. and 20 in. × 16 in. sugar pine or yellow pine, of good quality, to be well bolted down to the mudsills.

Mortar blocks to be made of two pieces each, to be 30 in. thick and wide enough to fill space between the linesills and battery posts; all to be sized and well fitted. The timbers for mortar blocks are to be accurately fitted together and secured with six 1 in. bolts, and two oak keys, 4 in. wide by 5 in. thick at the point and 6 in. at the head. Keys to be accurately fitted

and firmly driven. Blocks to be sized and finished above the floors.

Yokes to be made of 10 in. x 10 in. timber, well fitted and bolted to the linesills and battery posts.

Battery posts to be made of 12 in. x 24 in. and 30 in. x 24 in., good quality pine timber, to be dressed all over, and bolted down to the linesills with 1 in. joint bolts, the large posts to be made with double tenon on the bottom. The knee beams to be made of 12 in. x 16 in. timber, dressed all over. The knee posts to be made of 12 in. x 16 in. timber, dressed all over. The stringer on top of the knee posts to be made of 12 in. x 16 in. timber in two pieces, to be spliced with a ship splice 3 ft. long, stringer to be dressed all over. Knee posts to be framed into stringer with double tenons; outside stringer at end of knee beams to be made of 8 in. x 12 in. timber in two pieces, spliced with ship splices in center 3 ft. long, and to be dressed all over.

Bottom guide girt to be made of 12 in. x 16 in. timber, dressed all over, one piece for each twenty stamp battery, and to extend past the outside posts 12 in.; the top girt to be made of 12 in. x 14 in. timber, dressed all over, and made the same length as the lower ones; all braces to be made of 8 in. x 12 in. timber, dressed all over, and framed with double tenons; no keys are to be used in braces or guide girts, but they must be accurately fitted without.

All boxing about battery frame to be 1/2 in. deep, and where braces or knee beams are smaller than the timbers they frame into, they must be housed in 1/2 in. deep; i. e., the timber must not be boxed out clear across.

The cam shaft is to be set 4 1/2 in. from the center to the center of the stems.

A 2 in. plank floor is to be put on top of the knee beams, which is to be planed on the underside; also, a 2 in. double board floor to be put in back of the battery, on about the same level as the knee beams.

The whole battery frame to be painted with two coats of light cream paint, properly mixed with oil, and the wood pulleys and guides to be painted blue, the iron work to be painted black. The outboard bearing frame to be made of 12 in. x 16 in. timber, planed all over, well framed and bolted together, and anchored to a solid stone foundation, as shown in plan, and to be painted same as battery frame.

Water wheel frames are to be made of 12 in. x 12 in. lumber throughout, well anchored down to a stone foundation. That part of the frame which comes above the floor is to be dressed and painted the same as the battery frame.

The water wheels are to be housed with tongued and grooved lumber, 4 in. wide.

BUILDINGS.

Frame Work.—Ore house main frame is to be made of 8 in. x 8 in. timbers throughout, with 3 in. x 6 in. girts and studding.

Battery and concentrator rooms frame is to be made of 8 in. x 10 in. posts and chords, 6 in. x 10 in. sills, 8 in. x 8 in. principal rafters and straining beams, 4 in. x 8 in. truss braces, and 3 in. x 6 in. girts and studding.

Clean-up, sulphuret, and water wheel rooms main frames are to be made of 8 in. x 8 in. timbers, with 3 in. x 6 in. girts and studding.

Floors.—Ore house floors to be made of one thickness of 2 in. planks.

Battery, concentrator, and water wheel rooms floors are to be made of 1 in. x 8 in. lumber, double thickness, surfaced on top, to be supported on 3 in. x 6 in. joists 18 in. apart.

Sulphuret and clean-up rooms floors are to be made of concrete laid on top of a heavy wood floor, which is to be supported on foundations made of 8 in. x 8 in. timbers.

Roofs.—All roofs are to be made with 2 in. x 8 in. rafters 18 in. apart, with 1 in. x 6 in. board 4 in. apart, and covered with No. 36 standing seam, painted, iron roofing.

Walls.—All walls are to be covered with 1 in. x 10 in. rustic.

Cornices.—All cornices are to project 34 in. measured horizontally from the walls of building, with a 12 in. frieze and a 5 in. fascia made of dressed lumber.

Windows.—All windows except those for sulphuret room are to be made of twelve lights of 10 in. x 16 in. glass, and frames made to suit of dressed lumber, with casing outside 5 in. wide.

Twelve windows are to be put in the ore house, seven windows in the battery room, six windows in the clean up room, twelve windows in the sulphuret room, and five windows in the water wheel room.

Six skylights, made of twelve lights of 10 in. x 30 in. glass, to be put into the roof of the concentrator room.

Doors.—All doors, both sliding and swinging, to be 3 ft. x 7 ft. x 1 1/2 in. thick, with panels.

Two sliding doors are to be put in the ore house, and one outside swinging door in the battery room; one swinging door leading from the battery room to the clean-up room, two sliding doors leading from the concentrator room to the sulphuret room; two outside sliding doors for the sulphuret room, and one outside swinging door for the water wheel room.

All doors to be set in good substantial casings, outside cased with surfaced lumber, and furnished with all trimmings and locks.

Stairs.—There is to be a flight of stairs at each end of the mill, one flight leading from the battery room floor to the floors above, and one flight of stairs from the battery room floor to the concentrator room floor.

All stair stringers to be made of 2 in. x 12 in. lumber, and treads of 2 in. x 10 in. lumber.

Hand rails are to be put on to the outside of all stairs and around the landings of same, also in front of the battery room floor and all other floors and platforms where there is danger of falling. All to be made of dressed lumber, well painted.

Retort House and Assay Office to be 30 ft. wide by 48 ft. long, with a retort and melting furnace room, a weighing room, and a storeroom; the two latter to be bath and plaster finished, and the whole building to be finished similar to the mill buildings, with iron roof, rustic, etc.

Paint and Whitewash.—All buildings are to be painted on the outside with a good coat of brown mineral paint, and the window and door casings and cornices to be painted with two coats of white lead paint.

The mill to be whitewashed throughout the inside, including the building frame, ore bins, etc.

Tanks.—There are to be two 4,000 gallon redwood tanks, 3 in. stock, set up at the end of the mill upon strong timber foundations, and one tank 8 ft. wide by 10 ft. long by 4 ft. high, inside measurements, to be made of 3 in. planks, with 8 in. x 8 in. frame; planking to be well fitted together, and properly calked inside with oakum. The latter tank is to be set at the end of the last sluice box coming out of the mill.

Drain Boxes and Tailings Sluices.—Battery sluices and aprons to be set on framework so arranged that the grade can be changed easily. This framework to be planed all over. Sluices and frames to be painted same as battery frame.

There will be a sluice in front of battery room floor, made of surfaced lumber; also to be painted and so arranged as to conduct any water away which drips from the floor.

There will be sluices put in under the concentrator room floor, two of which will be 6 in. wide by 8 in. deep, to run lengthwise to catch the tailings from the concentrators, and one to be 8 in. wide by 10 in.



M. PAUL ROLIER, AERONAUT.

deep, to run crosswise and to take the tailings from the first two sluices, and conduct the same outside. All tailings sluices to have a fall of one in twelve, and to be made of 2 in. lumber, well fitted and nailed together. Proper sluices from the clean-up room, to conduct water and tailings therefrom, must be connected to tailings sluices under concentrator room.

All sulphuret boxes, and drain boxes for concentrators, to be made of good quality of redwood lumber, 1 1/2 in. thick, dressed on both sides, and well fitted and screwed together.

The weight of all parts is 240,000 lb. and there are 325,000 feet of lumber in the building.

Specifications for a canvas plant are not considered necessary, as the construction is extremely simple and no standard has been adopted. Full descriptions are given in the preceding pages.

A WONDERFUL BALLOON VOYAGE DURING THE SIEGE OF PARIS, 1870.

WHEN Paris, in 1870, was invested by the Germans, the only communication with the outer world was effected by means of balloons. During the siege, no fewer than sixty-five of these aerial ships left the city, conveying 150 people (among them Gambetta) and about 4,000,000 letters. Of these sixty-five balloons, five were captured, two were lost (probably in the Channel), and one (the Ville d'Orléans) descended on the summit of the Lifjeld, Norway, represented in the accompanying illustration, after a voyage of fourteen hours thirty-five minutes from Paris. The heroes of this journey were M. Paul Rolier, aged twenty-nine, a civil engineer and member of the Legion of Honor, who acted as aeronaut, and M. H. L. Dechamps, an

them, and endeavored to reach them, but without avail. A mail bag had to be sacrificed to allow of the balloon ascending again, and they then kept well away from the sea at a height of 2,700 yards. At 12:30 p. m. they were enveloped in a dense fog, and at one o'clock the two men felt so desperate that they decided to set fire to the gas, preferring death to the mental torture of anxiety they were enduring. Fortunately for them their clothing and everything else were enshrouded in a thick coating of hoar frost, and the matches would not ignite. At 2:30 they observed a high mountain ahead, determined on descending, and almost immediately afterward the car touched the stump of a tree which protruded from the snow. Rolier leaped out at once, but Dechamps' foot became entangled in the grapnel rope, and he hung head downward from the car, which, with the balloon, commenced at once to ascend rapidly. Fortunately Rolier caught the rope, and Dechamps, getting clear, dropped unhurt into the deep snow.

This happened on Friday, the 25th of November, 1870, at 2:25 p. m., says Dechamps in his journal. "We were saved as if by a miracle, but our prospects were anything but hopeful. We found ourselves in an unknown land, exposed to snow and frost, without food, almost without clothing, as our balloon had sailed away from us, taking with it our dispatches, our pigeons, provisions, and wraps. After a short consultation as to the direction we should take, we commenced our descent. After two hours' hard walking Rolier became so tired that he could not proceed further, and sinking down exhausted remained lying in the snow. I saw some fir trees not far off, and succeeded in conveying him to one of them and laying him across two branches, where he fell asleep. I was excessively fatigued, but deemed it expedient to continue my walk to see if it were possible to discover a human habitation. Fortunately I had not to go far ere I perceived a little hut some fifty paces ahead of me. My exhaustion vanished immediately, and I was soon in my 'palace,' and found it filled with hay. To hurry back to the tree where Rolier lay in deep slumber, lift him down, drag him along and hurry him into the hut was the work of a moment. It was high time he got there, for his feet had already become so stiff that a longer stay in the tree would have been certain death to him. The first thing we did was to clear off the snow which had got in through the open roof, and then we buried ourselves in the dry hay, where we found warm and refreshing rest. We woke at 6:30 a. m. on Saturday, the 26th of November, a little over thirty hours since leaving Paris. After shaking ourselves well we continued our journey, and after a time came upon the tracks of a sledge, and understood now that we were not far from people. We followed the traces, and soon arrived at a hut and went in. Nobody was there, but some embers smouldered on the hearth, and to judge by appearances its occupants had only lately left it. We found a match box on the table on which was printed 'Christiania,' and from this we concluded we were in Norway."

THE LIONS OF THE DAY.

During the course of the day the wood cutters returned to their hut, treated the poor famished Frenchmen with every kindness, and fed them on pork, sausage, potatoes, goat's milk, butter and "flat bread," the latter being described by Rolier as "a sort of paper made of oats." In the afternoon their hosts sledged them down through the forest to Siljord, where they were most hospitably entertained, and driven thence to Kongsberg, en route to Christiania, where they were received with the greatest enthusiasm and made the lions of the day. The balloon itself finally dropped in the parish of Kordsharred, some thirty miles north of Draumen. It was presented by Rolier to the University at Christiania as a mark of his appreciation of Norwegian sympathy and hospitality. The first glimpse of this balloon was obtained at Mandal, South Norway, and the London evening papers of the 25th contained the telegram



The Lifjeld Mountains, Telemarken, on the highest point of which the aeronauts descended, November 25, 1870.

FIG. 1.—A WONDERFUL BALLOON VOYAGE—THE LANDING PLACE.

officer of Franc Tirailleurs. They ascended from Paris at 11:40 p. m. on the 24th of November, 1870, with dispatches from General Trochu, Governor of Paris, to the army of the Loire, and conveyed also about 500 lb. weight of private letters, ten bags of ballast, some provisions, and six carrier pigeons. The wind was fresh from S.E., and all went well for a while, until, when day dawned, at 6:15 a. m. on the 25th, they found themselves over the sea with no land in sight.

Both men were nearly paralyzed with the horror of the situation, and Dechamps fairly broke down. Rolier regained his nerve to some extent, and at 11:15 descended to within a few yards of the water in the hope of being succored by a schooner which observed

from that place dated about noon: "A balloon, supposed to be from Paris, has just passed, proceeding in a northerly direction," or words to that effect. Subsequently the Gazette de France of November 25, 1870, and other papers which had been thrown from the balloon were picked up in the fjord and country near Mandal, and have been religiously preserved in the archives of the borough.

The balloon itself has long lain hidden in the cellars of the Christiania University, but on November 25 last it was exhibited in the students' club to a large gathering assembled there to celebrate the twenty-fifth anniversary of its arrival with MM. Rolier and Dechamps in Norway. To an unpracticed eye the relics

seemed to be not only in perfect condition, but those of a first class balloon. An aeronaut who addressed the meeting designated it as a very primitive contrivance, and explained the improvements which have been introduced in their construction during the last quarter of a century. The voyage of the *Ville d'Orleans* must be regarded as the most remarkable of any undertaken since balloons were invented, not only from the success which attended it, but from its extra-

ally at Pekin, where a very large one may be seen in the temple of the Great Bell. It bears the name of "Takung-su," and was cast in the year 1578 of our era. It is 16 feet in height and is suspended in a tower erected back of the temple. Its surface is covered with inscriptions that give the precepts of Buddhism. The letters upon the metal are in relief.

In Japan also there are some large bells—at Kioto especially. One of them is 14 feet in height and weighs

We read in Theocritus that the ancients caused the sound of small bells to be heard in their sacrifices, as in the mysteries of the Corybantes and of Bacchus. The ass of Silenus had a bell suspended from its neck, as had most cattle. As for true bells, that is, those of large size, they served for the same purposes as they do in our own epoch.—*La Nature*.

THE TECHNICAL LITERATURE OF THE YEAR.

FROM year to year, whatever else may happen, there is steadily poured forth an increasing flood of technical literature, and the year that recently came to a conclusion forms no exception to the rule, whether in regard to quality or quantity. No very startling developments have been produced, but rather the year has been one of steady progress in the world of mining and metallurgy so far as purely technical matters relating to coal and iron are concerned. The literature of these industries far exceeds that of any other subject, and naturally so when it is considered that the world's output of coal last year amounted to more than 550 million tons, iron ore to 50 million tons and pig iron to 25 million tons.

Great Britain and the United States contribute most to these outputs, but their shares in the literature are equalled or even surpassed by that in the German language, and of course the French tongue is also well to the fore, as might be expected with the important coal and iron districts of France and Belgium. The other European countries add a not inconsiderable quota, but most people prefer to take Russian and Hungarian for granted, if translations are not available.

The geology and occurrence of coal has met with its usual amount of notice. In this country the president of the geological section of the British Association devoted the greater part of his address and a subsequent paper to the geology of the eastern counties, especially with reference to boring for coal, and the systematic exploration of the deeper measures of this country was advocated by other speakers. The correlation of English, French and Belgian coal measures still attracts attention, and a learned paper before the French Geological Society dealt with the whole system of classification of the coal-bearing formation throughout the world. Papers of more or less importance have also appeared in all the leading journals on individual coalfields. Of these, one by Mr. Lyman, before the American Institute of Mining Engineers, is especially interesting, as he has collected and reproduced on a uniform scale nearly 200 sections of the Pennsylvania district in order to determine, if possible, the disputed question of the symmetry of the basins and saddles in that field. Another that may be mentioned is by Mr. H. W. Hughes on the South Staffordshire district. Both in South Africa and in West Australia coal mining has been pushed forward in order to supply fuel for the goldfields, and particulars will be found in a recently published book, "The Gold Mines of the Rand," for the former, and in the government reports for the latter country.

The composition of coal has been dealt with before the Manchester Geological Society and the Andersonian Naturalists' Society in some small contributions of general nature. A somewhat novel addition to the constituents of coal has been made by more than one observer in the form of gold, two or three samples of coal having shown up to $\frac{1}{2}$ oz. of the precious metal per ton. The presence of large quantities of vanadium was noticed in some Peruvian coal a few years ago, and now considerable quantities have been separated. The ash of coal has been carefully studied by M. Prost in the *Revue Universelle des Mines*, and a complete series of analyses and determinations of its fusibility have been made for a large number of Belgian coals. The Berthelot-Mahler bomb for the estimation of calorific power has found an increasing use.

The literature of coal mining is marked by a renewed interest in the methods of dealing with dust in dusty collieries, and by general discussions on and further experiments with the high explosives both in this country and in Germany. At present the United States have paid but slight attention to either of these matters, but are more interested in coal-cutting machinery.

Everywhere the electric transmission of power is



The remains of the balloon preserved in the University Museum, Christiania.

FIG. 2.—A WONDERFUL BALLOON VOYAGE.

ordinary rapidity, the distance in a straight line from Paris to the Liffeld Mountains in Norway being 750 miles and the time occupied 14 hours 35 minutes. The distance traversed was however doubtless much greater as on leaving Paris it traveled rapidly in a N.N.W. direction, and probably passed over the channel and a portion of England ere its course was turned by a southwest current in the direction of Scandinavia. For our particulars and illustrations we are indebted to the London Daily Graphic.

LARGE BELLS.

MUCH has recently been said about gigantic bells in connection with the subject of the "Savoyarde," which was cast at Annecy-le-Vieux (Haute-Savoie). This bell, weighing more than 35,000 pounds, was carried from the place of its manufacture to the church of the Sacred Heart, at Paris-Montmartre, and greatly excited the curiosity of the public.

It is not known to everybody that bells of this kind are widely distributed in India. Specimens of very large dimensions are sometimes found near the pagodas and bonzeries. They have no clappers and do not possess so flaring a form as ours. Some of these bells are of an enormous weight. The largest bell of the pagoda of Rangoon, which we shall speak of further along, weighs 111,000 pounds. These bells are made to resound by striking them externally with a stag's horn or a piece of hard wood. The strokes should be well given.

We have received a very interesting photograph of a large bell of Burma from Mr. De Ginoux, one of our readers. It resembles those of which we have just spoken. We reproduce this photograph herewith, along with a copy of the letter on the subject addressed to us by Mr. De Ginoux:

"The Savoyarde and its dimensions have attracted much attention. This reminds me of a monstrous bell that I saw last year in Burma, at Mingan, opposite Mandalay, upon the right bank of the Irawaddy. It is 16 feet in height and 14 $\frac{1}{2}$ feet in diameter. Supported by three strong beams resting upon masonry pillars, it disappears under a confused mass of climbing plants that overrun it. The Burmans have a great reputation for the casting of bells, of which fine specimens are met with at Rangoon, Prome and a little everywhere throughout the country. They excel also in the manufacture of gongs of a special form, which, being struck with a wooden mallet that gives them a rotary motion, produce sounds of an incredible purity and intensity. I send you a photograph that I took myself at Mingan with a Carpentier photo-jumelle; thinking that this communication might interest your readers as well as founders."

There are also analogous bells in China, and especi-

ally at Pekin, where a very large one may be seen in the temple of the Great Bell. It bears the name of "Takung-su," and was cast in the year 1578 of our era. It is 16 feet in height and is suspended in a tower erected back of the temple. Its surface is covered with inscriptions that give the precepts of Buddhism. The letters upon the metal are in relief.

One of the largest bells in the world is that of Moscow, in Russia, which is 19 feet in height and is exposed upon a public square.

After these details as to large bells, we shall have a few words to say as to their history. According to Father Kircher, the invention of bells must be attributed to the Egyptians, who announced the feasts of Osiris therewith. On another hand they appear to have been known in China more than 2,600 years before Christ. There is no doubt that hand bells were much used in ancient times.

According to Clement of Alexandria, the high priest Aaron carried small bells at the bottom of his robe.



A LARGE BURMAN BELL.

advancing with rapid strides. Several large installations in American collieries have been described in their own papers and in this country. Mr. Robertson's paper on electric haulage at the Earnock Colliery, read before the civil engineers, has provoked a most useful and interesting discussion. At the same time it may be said that underground haulage by compressed air locomotives is far from losing its ground, as is shown by Mr. Gresley in a paper before that useful little society the British Mining Students, and in other more recent publications. Electric haulage, it would appear, has now arrived at a stage somewhat similar to that of rope haulage when the North of England Institute held their famous inquiry. The feasibility of the systems is beyond all question; it is simply a matter of determining the one that is most advantageous to the mine.

The colliery question has been so fully dealt with in these columns throughout the year, that it would be mere repetition to mention other sources of information, and the same may be said with regard to explosives. The Transactions of the Federated Institute also deal fully with the latter, especially with discussions on the North of England Institute experiments, and also with those conducted by Bergassessor Winkhaus at the Dortmund Collieries. One or two new means for igniting blasting fuses have been described. In Belgium it has been suggested that blasting in collieries should be prohibited by international agreement, but the idea was promptly negatived. The behavior and occurrence of fire-damp still occupies a fair amount of space in the French journals, and in this country also outbursts of gas have been described. Prof. Clowes pursues his investigations on fire-damp, and the Hardy detector, which depends on the sound of a whistle, has been criticized by M. Râteau. Very little has recently been heard of miners' electric lamps.

The modification of the Foetsch system, which has been used for sinking large shafts at the Vieq pits, Anzin, in France, have been very fully described before the Société de l'Industrie Minière, and a short description is given in the abstracts published by the Institution of Civil Engineers. Several accounts of other sinkings appear in French and German periodicals, and to these may be added a description of a rapid method for repairing a heavy fall in a shaft at the Liévin collieries. Several automatic gates for landings have been introduced in the Pas-de-Calais, and are illustrated in the Annales des Mines.

Pumping appliances have been fully dealt with in a series of articles in this journal, and elsewhere isolated descriptions of large pumping plants and flooded mines have appeared. Neither is ventilation neglected. Mathematical investigators have been busy in Dingler's Journal and other papers, and each form of fan finds its strenuous supporters, but, on the whole, the activity displayed in this direction two years ago has not been sustained. Mr. Bryan Donkin has conducted experiments on several different forms of fans, but these relate rather to the types used in the foundry; another more recent paper and discussion, also at the Institution of Civil Engineers, is not without value to the mining engineer.

Several writers continue to deal with coke ovens and the recovery of by-products. The Semet-Solvay and the Otto-Hoffmann ovens are vigorously advocated by their respective admirers, who publish accounts of what their ovens will do in producing increased percentages of coke, ammonia and tar products. Meanwhile, the beehive ovens have found one or two advocates to throw in a word here and there. Several coal washing and screening plants have also been described, and in some instances admirable drawings have been published, but no startling novelties have been produced. Explosions in briquette plants have been investigated. Of other fuels there are natural and artificial gas, peat, charcoal and oil. Practically nothing has appeared as regards natural gas, peat or charcoal. Modifications of producers are constantly being invented, but otherwise they have met with but scant notice, although a few accounts of water gas and of the use of gas in foundries have been published. Petroleum and allied products have gained more attention, for the discussion on the origin still attracts incidental notices. The earlier part of the year was more fertile as regards this subject of oil generally, and the most important paper was one on the Alsace district before the Federated Institute.

Interest in iron ore centers chiefly in the vast deposits of the Lake Superior district, and more especially in the Mesabi range. This—the youngest of the five great districts known as the Marquette, Menominee, Gogebie, Vermilion and Mesabi ranges—already nearly overshadows its congeners, both in extent and output, although its situation is not so advantageous as some of the others, and the ores produced are so soft that it is somewhat difficult to use them in the blast furnace. The fourteenth annual report of the United States Geological Survey is largely devoted to the geological occurrence of the iron-bearing rocks, and nearly all the American papers deal at considerable length with economic considerations on the district and with the methods of mining and utilizing the ores.

In Europe, the deposits of Norway and Sweden occupy the predominant place, owing to the extensive developments of the Ljosavara, Gellivara and other districts. Spain and Germany have not been neglected, the French have been investigating the Congo district, and a full account of the deposits in the island of Elba is given by Mr. Scott in the Iron and Steel Institute Journal. Chrome ore in Australia and manganese ore in Spain have also been dealt with, the latter before the Institute of Mining and Metallurgy. Electric rock drills are again coming to the fore in several papers. Magnetic concentration has scarcely been dealt with at all this year, but some attention has been given to kilns for calcining ore.

The year has been productive in several rather interesting accounts of the manufacture of iron. In historical matters, the Archæologia Cantiana, unfortunately, a very inaccessible publication of a Kentish society, includes a description of the ancient local iron industry. Beck's mammoth history of iron is still appearing, the last sections coming down to the seventeenth and eighteenth centuries. An abridged translation is also appearing in our contemporary, the Iron Age. Other history is to be found in Prof. Sexton's

paper on the hot blast. The German blast furnaces, and ironworks have been described at length in connection with the visits of the Mining Congress; some of the French ones also by the Société de l'Industrie Minière, and on the American furnaces there is always a kind of running commentary in the United States papers. The discussion which raged on the use of dolomite and magnesian limestone in the blast furnace as a flux has nearly died down. The recovery of by-products has had an interesting addition in the fact that considerable quantities of iodine have been recovered from the dust separators.

The literature of the foundry has increased again during the past year to a considerable extent, but this is practically only in America, where a vigorous body—the Western Foundrymen's Association—devotes all its energies to that trade. A year or so ago the chief subject was moulding machinery, then replacement of cast iron by steel and advance in foundry methods, while now it is economy in the foundry and foundry cost sheets.

A very important communication on puddling has appeared this year from M. Bonehill on puddling liquid metal taken from a reservoir supplied from the blast furnace. The puddling furnaces are gas-fired, and there appears to be great economy both in material and labor from thus treating molten metal instead of solid pig iron. This paper was read at the Birmingham meeting of the Iron and Steel Institute, and is certainly of great importance to a somewhat decadent industry. Beyond this and other communications on the same subject, there has been nothing much to record in the wrought iron trade.

Early this year several noteworthy descriptions of crucible steel manufactures for tool steel were put forward, dealing with material made in the Poutiloff Works, in Russia, and with tungsten and other special tool steels. The more important methods of open-hearth and Bessemer, both acid and basic, have received the usual amount of attention. Several large works have been put up in America, and of these plans and descriptions are to be found, while German works are also described. The enormous developments in Russia are shown by a comprehensive account given by Mr. G. Kamensky before the Iron and Steel Institute. In the details of steel manufacture, the lining of converters has taken a considerable place, and also the general construction of open-hearth furnaces. Further experiments have been made with the Saniter process of desulphurization by calcium chloride, and the Hoerde mixer process has not been neglected, but the discussion as to the relative merits of these processes has died away. Processes for recarburizing steel are still being considered, and experiments have been made, according to a German report, with calcium carbide.

Apparently this agent is not a success. The small or Robert converter appears from one or two accounts to be doing well, and the basic process is still advancing abroad, though not greatly in this country. Replies to a circular letter of inquiry on the future of the basic process were published in one of our English contemporaries last January.

Mr. James Riley gave a very good account of modern steelworks machinery at the Glasgow meeting of the Institution of Mechanical Engineers, and in America some of their recent plants have been described. In that country the re-rolling of worn steel rails appears to have been brought to a successful issue. Steam economy and electric power in rolling mills were still under consideration early in the year.

Nickel steel for armor plates and generally for many other purposes has been widely adopted in the United States, but discussion still rages around this material in our own country, where the position taken up is best set forth in Mr. Wiggins' paper on nickel steel and in the discussion which ensued at the Birmingham meeting of the Iron and Steel Institute. Other notices of armor itself have been rather scant just lately.

A somewhat lengthy discussion, carried on from the previous year, continues between two parties, known now as the allotropists and the carbonists, and represented by Messrs. Roberts-Austen and Osmond, on the one side, and by Messrs. Arnold and Hadfield, on the other; the former ascribe the hardening of steel and many other of its properties to the formation of allotropic modifications of the metal, while the other side believe that they are purely due to the presence of carbon. These views are upheld or combated, and midway positions are taken up by numerous experimenters all over the world at great length. Among the contributors may be mentioned Messrs. Curie, Charpy and Howe.

The microstructure of iron and steel has been further dealt with by Mr. Andrews and the Royal Society, and, arising out of papers taken some time ago at the American Institute of Mining Engineers, the subject has been discussed in Stahl und Eisen.

Mr. Keep pursues his investigations into the strength, contraction, chilling and other properties of cast iron, and the influence on them of extraneous matters. In some of his conclusions he is opposed by Mr. West, and accounts are to be found in English and American sources.

Another discussion that has practically drawn to its close is on the influence of vibration on steel, which was alleged by some to produce crystallization of the metal. This is now concluded to be merely a delusive appearance, and careful annealing is decided to be the best remedy for what in the absence of exact knowledge has vaguely been termed "fatigue." Experiments upon this matter are in competent hands.

This list of controversial matters might easily be extended to double its length, but the main points discussed during the year are included above.

Most, if not all, of these subjects have been treated of in the Colliery Guardian, but many of them of necessity with great brevity, owing to exigencies of space. Nevertheless, it has been thought that this brief review of the subjects dealt with in the literature of the year might be of interest to the reader.—H. G. Graves, in the Colliery Guardian.

The largest black diamond yet discovered in Brazil has recently been examined by M. H. Moissan, who has furnished a description of it to the Comptes Rendus of the Paris Académie des Sciences. The stone in question weighed 3,073 carats.

THE FORENSIC ASPECT OF HYPNOTISM.

By H. GERALD CHAPIN, LL.B.

THE belief in the power of one being, either spirit or man, by the exercise of the subtle agency of will to control the mind of another as he does his own, has existed in different forms since the earliest periods of the world's history, although it is but lately that this belief has taken the form of a definite theory. Dr. Le Plongeon has found among the ruins of the Maya cities of Yucatan, upon the walls of an ancient palace, two engravings, one representing the hypnotist in the act of putting the subject into the mesmeric sleep and the other the recording of what the hypnotized subject is saying. The belief in the possession by devils (that is, by what is now known as the power of suggestion, the evil spirit may govern the minds of certain human beings) is an instance. Touching for the king's evil shows this belief, and the latest manifestation before the matter was reduced to a definite theory was probably shown during the Salem witchcraft. The first alleged victims, the children of the Minister Parris, claimed to have been compelled to perform certain acts wholly irrational in their character, by reason of the coercive influence of an Indian servant. In Paris in 1778 Mesmer, following the path a short time before marked out by Giannini, propounded his theory of animal magnetism, into the consideration of which it would be foreign to our purpose to enter. Suffice it to say that the belief in the existence of a subtle indwelling fluid (magnetism) which might emanate from the one individual and pass to the other, or might be transferred to inanimate objects, forms the basis of the doctrine laid down by him. Some time later Braid, by discarding the fluidic theory and giving a name to the new-found power, calling it neuro-hypnotism, at last placed the matter upon a scientific basis. Afterward Liebeault, at Nancy, and Charcot, at Paris, founded the two schools that bear their name.

A statement of the differences in their respective theories may not be improper at this juncture. Briefly, it is this: Under the former system all psychic phenomena are attributed to suggestion; in the latter suggestion is denied and the phenomena are referred to physiological causes. The latter also denies that true hypnosis may be produced in persons other than those suffering from enfeebled nerve power, but their chief differences are with regard to the existence of the power of suggestion. Having thus endeavored to give a short sketch of the history of the hypnotic theory, I will examine the present subject as follows: First, hypnotic influence from the standpoint of civil law, then, with regard to its possible effect upon crime. Lastly, we will discuss the availability of testimony obtained through its means and the propriety of statutory restriction upon the exercise of this power.

As to the question of the compellability by suggestion to the commission of crime, psychologists differ. On the one hand are Liegeois and Lafargue, Forel and Moll. On the other Gilles de la Tourette, Pierre Janet and Benedikt.

A solution of the problem may, perchance, be arrived at when we consider, as I have before said, the immense power of auto-suggestion. Let us take a man who has passed his life as an honest, law-abiding citizen. Imagine him placed in the hypnotic state and ordered to murder his dearest friend. Would not his very soul loathe the thought? Would not every fiber of his being, every power of his mind, every atom of his will, resist so atrocious a suggestion? Could the command of the hypnotic agent, however strong and however much reiterated, prevail against the auto-suggestion of the subject? Thus, it is a well known fact that persons opposed to the use of intoxicating liquors cannot be compelled to drink a glass of brandy while in a state of hypnosis.

On the other hand, instead of he who has just been mentioned, let us suppose some hardened criminal. Here would not the fear of future punishment operate as a very powerful self-suggestion, and in the more heinous crimes the subject must have been criminal to an extent rarely met with who could, at the mere will of another, without resistance upon his part, commit a crime from which he could derive no possible benefit. But if we concede that one may, while in a state of hypnosis, be forced to commit a crime, we must also admit that it may be suggested to him at that time that another has done the wrong, or the suggestion may be to forget all about the matter at all times and in all conditions, whether hypnotic or non-hypnotic, which would place the hypnotism in a perfectly safe position, so far as human laws are concerned, and we shall be obliged to take into consideration that every case of crime, especially that which is apparently motiveless, might be the result of hypnotism.

But, even admitting that the suggested crime may be carried out by the subject, nevertheless the following must be considered. Drunkenness of itself constitutes no excuse at law for the commission of a crime, for the reason that, as a general rule, it is not something that may be forced upon a party contrary to his desires, but is entirely voluntary on his part. The law says that, having voluntarily induced intoxication, it would be ridiculous to acquit the defendant on that score, as if that were done, drunkenness would be very certain hereafter to be the prelude to every crime. Now, may we not regard hypnotism in much the same light? It is conceded that no one may be placed in the cataleptic or somnambulic state contrary to his desire and against his resistance. If, therefore, a subject, knowing well that while in a state of hypnosis he may be compelled to commit crime, voluntarily suffers himself to be placed in that condition, may he not be supposed to have anticipated all the consequences of his act and agreed to become responsible for them?

A point of real danger, however, appears to be this. Suppose it is suggested that a false state of facts exists, which would, if true, justify the commission of the offense. For instance, that the murdered party was about to take the life of the subject, and that the subject was to take his in self-defense. This I meet by the last argument. A person is about to be placed under hypnotic influence. By a comparatively slight exertion of will power he might resist it and refuse to allow himself to be placed in the cataleptic condition. He does not, and permits the agent to throw him into a state of hypnosis, well knowing that while in that condition he may be compelled to commit crime. Can

he not be said to have foreseen and agreed to be responsible for this as a natural and probable consequence of his omission? Then, again, let us suppose a murder has been committed in the presence of several witnesses. Suppose, to make the case still stronger, that it was, so far as it appears, entirely motiveless. The murderer claims to have been hypnotized by X and compelled to commit the crime. What defense so hard to disprove! The matter rests entirely in the mind of the defendant.

The question to be determined by the jury is as to the existence or non-existence of a certain condition of the murderer's mind at the time of the commission of the offense. He says that X had placed him in a condition of hypnosis. He says that while in that condition he urged the commission of crime by him. He says that he was unable to resist, etc., and no one is able to disprove what he says. If he is discharged, his acquittal means the indictment of X, whose conviction cannot help but follow, for what accusation so difficult to disprove! It is shown that X possessed hypnotic power. The prosecution may rest there, since it has made out a prima facie case. But suppose Y and Z have that power also. Why should they not be placed on trial, since either of them might have been the guilty party instead of X, unless X, indeed, is chosen because of the uncorroborated testimony of the murderer? In this way every one known to possess hypnotic power becomes an object of suspicion. For the power of suggestion is limited neither by time nor space.

I may place A in the somnambule state and suggest to him that on the following Tuesday at 10 o'clock he will fall into a deep sleep which will last an hour. I then wake him. On the following Tuesday, at the time indicated, the event happens. Now, if we admit that criminal suggestions may be carried out by the subject, we must also admit this power of post-hypnotic suggestion, which would afford complete immunity to the real criminal, since in the space of time between the suggestion and its execution the agent might place himself with the greatest ease beyond the arm of justice.

We should not fail to speak in this connection with regard to a certain propensity in all hypnotized subjects upon the commission of the act to assign some ulterior reason for doing the same rather than the fact of the suggestion itself. Thus in a series of experiments made by Prof. Moll, of Berlin, who is, in all probability, the best of modern hypnotists, he said to the subject:

"After you wake you will take a book from the table and put it on the bookshelf." She wakes and does so. When asked her reason she replies: "I do not like to see things so untidy; the shelf is the place for the book, and that is why I put it there."

Another case was where the suggestion was made that X, upon awakening, should use an insulting expression. He wakes and calls out "Donkey." When asked his reason he excuses himself and explains: "I felt as if I must say donkey." Another still stronger experiment was where the subject was ordered to take a flower pot from the window, wrap it in a cloth, put it on the sofa and bow to it three times, all of which he does. When asked for his reasons he answered: "You know, when I woke and saw the flower pot there, I thought, as it was rather cold, the flower pot had better be warmed or else the plant would die. So I wrapped it in the cloth and then I thought that as the sofa was near the fire, I would put the flower pot on it, and I bowed because I was pleased with myself for having such a bright idea." He added that he did not consider the proceeding foolish. He had told me his reason for so acting, and the learned professor adds:

"Most experimenters have observed that their subjects try to find reasons for the most foolish suggested acts."

Now, it is obvious that, applying this principle to the case in question, upon the commission of the crime, hypnosis would be the last reason that the subject would assign as a defense. In case it had been suggested to him that the deceased had been attempting to murder him, he would, in all probability, insist upon the existence of that fact and not that he had been hypnotized. Had he simply been ordered to do the act, some reason other than that of hypnosis would have been given by him. The very fact, therefore, that he should set up this defense shows that the crime was committed entirely of his own volition.

Another test which may be applied is this: Does the subject in his waking moments remember the commission of the offense by him? He says he does, but asserts that he did the act while in a state of hypnosis. But it is well known among psychologists that it is almost impossible that anything said or done while in the hypnotic state should be remembered in the post-hypnotic. For this reason does not the very fact that such a defense is interposed constitute an evidence of its falsity?

Let us examine a few of the reported cases in which hypnosis is claimed to have been urged as an excuse, and first let me state that all reported convictions for crime committed upon the subject (which consist chiefly of criminal assault) while claimed to be in a state of hypnosis must be excluded from our consideration, for, if the offense be proved, what difference is there whether it was committed while the injured person was in a state of hypnosis or not? In law proof of this condition in the person violated is not required to sustain a conviction where the fact of the crime has been judicially proved. Why, therefore, should the existence of hypnosis be inferred from the fact that evidence tending to show its existence was adduced by the prosecution and that the defendant was convicted? If I place A in a state of catalepsy and then murder him and am found guilty and sentenced, this case cannot be cited as an authority for the fact that this may be done. I am being tried for the murder alone. If guilty, I shall be convicted, whether it was done through the instrumentality of hypnosis or not.

Let us proceed to examine the celebrated Bompard-Eyraud affair, which was probably the first trial of any importance in which hypnosis was actually brought to the notice of a judicial tribunal. Concerning the crime itself, it is useless to speak further than to state that Eyraud murdered, in apartments hired for the purpose, one M. Gouffe, the woman, Gabrielle Bompard, his mistress, acting as the decoy. Upon the

trial, M. Liegeois, the great professor of the Nancy School, was called as a witness. In a long examination, lasting over four hours, he was only able to formulate suppositions and affirmations based only on laboratory experiments, which were subject to numerous criticisms, and convinced no one. Gabrielle Bompard was convicted and sentenced to twenty years' imprisonment. Numerous other pleas of this nature are said to have been entered, especially in Holland and France, and in this country in Eau Claire, Wis., and in the Meyer case, in New York, but in none has the matter been squarely passed upon by the court. There is a tendency undoubtedly existing at the present day, among lawyers of a certain class, to assign to hypnosis, as a defense, the place formerly occupied by insanity. It has become a recognized fact with the public at large that the latter is being constantly made use of as a dernier ressort when all legal excuses fail. A number of cases have lately arisen which demonstrate the fact that in a trial for some particularly heinous crime committed with no apparent motive, and, so far as may be learned, without a single extenuating circumstance, the defense of insanity is fairly certain to be interposed. So much has it been used that at the present day its force and effect are much weakened, and the mental alienation of the defendant must be apparent indeed, in order that the point may be raised by any well trained lawyer, since he knows that it is regarded by the majority of juries with great suspicion. Hypnotism is comparatively new. It is clearly understood by no one. It has a mysterious sound and figures very well as the subject of a sensational address to the jury, and, therefore, it stands an excellent chance of being made the future defense of every rotten case.

Let me, before closing this branch of the topic, say a few words of warning with regard to the so-called hypnotic cases which are every now and then called to our attention by the daily journals. We are confronted from time to time with long articles, under double headlines, telling of a case, usually somewhere "out West," where the defense of hypnotism has been interposed. In nearly every instance that I have been able to investigate has sensationalism been permitted to prevail over accuracy. I have in mind at this moment the case of the State of Kansas against Anderson Gray. We all remember how we were informed through the newspapers that the defendant had hypnotized the farm hand, McDonald, and compelled him by that means to commit the murder of one Patton, and how Gray was found guilty by the jury, "whose finding," as one leading magazine expressed it, "was confirmed by the Supreme Court of the State." I confess I was unable to comprehend what was meant in this instance by the word "confirmed." Certain it is that after a careful perusal of the decision of the Supreme Court, as set forth in the 39th volume of the Pacific Reporter, page 1050, I am compelled to admit that I fail to observe that the learned judge who delivered the opinion intended to lay down any principle, further than the well known legal rule that he who aids, counsels, abets, or assists in the commission of a crime is equally guilty as the person who actually commits the same.

Having thus regarded the subject of hypnotism from a criminal standpoint, let us now see whether it may be made use of for the purpose of obtaining testimony from the hypnotized witness.

And first, let me ask: Suppose the witness refuses to permit himself to be placed in a state of hypnosis under the direction of the court, what then? As has been shown, if the subject combats the influence, he is proof against its power. If his will resists that of the hypnotizer, not even the first hypnotic stage may be effected, and all inquiry is brought to a sudden close. To punish him for contempt of court for refusing to allow his will to become quiescent, and to keep on punishing him until he does, is upon its very face foolishness. Then, again, how may the subject be sworn? Shall the oath be administered to him in his waking moments, before being placed in a state of hypnosis? If not, then, according to the law of the majority of our States, he cannot be heard, since a witness who has not taken an oath or made some preliminary statement which statute declares to be its equivalent, is not permitted to testify. If so, then must he be held guilty of perjury if he testifies falsely? To hold him responsible for what he says at a time when his senses are not under his control is, to say the least, very hard justice.

The general rule of law is that statements made during sleep are not receivable in evidence, and the reason for this is obvious. As has been already said, the condition of the subject during hypnosis is almost identical with natural sleep. Why should this principle be broken through in the present instance? Is not the witness equally subject to some delusions in the one state as in the other? Are not his reasoning powers equally quiescent in both? What difference is there between the two that hypnosis sleep should constitute an exception to the general rule?

Let me ask another question. How are we to know whether the subject is in a hypnotic condition or not during the giving of his testimony? What tests have we that are not so fallible as to be almost worthless to determine whether he is actually in a state of hypnosis or merely simulating it and ready to turn the whole affair to his advantage? The dangers of simulation in a case like the present are incalculable. The physical phenomena of mankind are all more or less alike—a fact which has given to the study of medicine more or less exactness. On the other hand, states of feeling and modes of thinking vary with each individual. Although every subject enters into the hypnotic state in a manner more or less the same, yet points of difference will arise in each individual case by reason of the dissimilarity in temperament of the subjects. Lacking, therefore, any precise tests which may determine beyond any reasonable doubt whether or no the witness is in a hypnotic condition while testifying, the affair becomes a matter of supposition and guess-work.

Let us, however, suppose the subject to be at length really under the influence of the hypnotizer, what guaranty have we then against lying and fraud on his part? It is an ancient error to suppose that persons while in a somnambule state always speak the truth; this belief is not supported by facts. A witness while in that condition will, if he finds it to his advantage, testify utterly falsely, and, furthermore, as his memory

while in the hypnotic state is perfect, he will be able to tell a far more consistent tale in every respect than he would have been able to do while in a normal condition. I here again quote from Moll. He says: "I can safely assert that hypnotic subjects can tell falsehoods as well as if they were awake, and that subtle webs of falsehood are invented in hypnosis. Lombroso tried in one case to obtain a confession of a crime which had been proved, though the subject always denied it. The attempt was useless; the subject told the same tissue of lies as when awake. Laurent and Algeri give the same information. In any case a statement made in hypnosis must be received with caution; it might be an indication, but not a proof."

But even though the witness is perfectly willing to be hypnotized and is desirous while in that condition to answer truly any questions that may be put to him, there are still several important facts to be taken into consideration. Let it be imagined for the sake of argument that A hypnotizes B, and while in that condition orders him to murder C. B is tried for the crime and placed in a state of hypnosis for the purpose of eliciting the truth. Here there is no doubt but that there would be a perfect willingness on the part of B both to enter into the somnambule state and to tell all he knows while in that condition. A, however, is aware of that fact, and at the time of the order to murder, suggested to him further that he is to allow himself hereafter to be hypnotized by no one. That suggestions of this character are of sufficient force to prevent any further hypnosis, is doubted by no psychologist. The affair is, therefore, brought to a standstill. Or let us vary this and suppose that the suggestion is that B inform the court while in the hypnotic state that the original order to commit the crime emanated from X, or make some further statement equally false. With this in view, what guaranty have we that any statement made by the hypnotized witness is not the result of some previous suggestion, and that such witness is saying only what he has been beforehand ordered to say? Can any testimony obtained from him be relied upon when a fact like this is borne in mind? Or when the commission of the crime was ordered might not the real criminal have suggested to his tool that thereafter, at all times and in all conditions, whether hypnotic or non-hypnotic, the fact of the suggestion and all acts done in pursuance thereof shall be entirely forgotten by him? What guaranty have we, therefore, of the efficacy of hypnosis as a means of eliciting testimony? A short time since I spoke of the possibility of the subject refusing to enter into the hypnotic state at the will of the hypnotic agent appointed by the court, or refusing to make any statement. What tests may be laid down to determine in case of such refusal whether it is not the result of some prior order to that effect?

Let us now look at the matter from another standpoint. Upon being placed in the somnambule state, the mind of the subject is in a condition of perfect quiescence. His will is in abeyance. Any statements that he may make must be the result of another's volition and not of his own. If not the result of some prior suggestion, then it must be the result of the suggestion of the hypnotic agent appointed by the court. He suggests, we will say, that the subject reveal the facts which led him to commit the crime. The subject states them. How may it be known but that every word spoken by him is not uttered in pursuance of some suggestion of the present hypnotizer? To make the matter clearer, let us suppose that the court orders A, a celebrated hypnotist, to place B, the murderer, in a hypnotic state, and interrogate him with respect to the crime. B gives his testimony concerning the matter. How are we to know but that A is mentally suggesting to him the very wording of his answers, for it is, of course, understood that suggestions are capable of being made mentally, and are not restricted to physical means of communication. Suppose even A to be acting innocently, yet (I take this merely as an illustration) even if he had a theory as to how the crime was committed (and what scientific man would not have?) would not his belief in that theory, even unconsciously to himself, perhaps, operate as a suggestion to the subject to testify in accordance therewith.

I shall consider one more point. Let us not forget the tremendous power of auto-suggestion. The instinct of self-preservation and self-interest is implanted in the very fibers of our being. In matters affecting them, the very strongest exercise of our will power is brought into play. Suggest anything you please to the subject, and so long as it affects neither of these he will obey. Suggest anything that tends to their injury, and he will resist to the utmost. The moment, therefore, that any suggestion is made requiring the disclosure by him of anything against his material interests, his reputation, or the secrets of his friends, committed to his care, an auto-suggestion of the very strongest kind arises, utterly forbidding the witness to answer, or commanding him to answer falsely, and which utterly destroys the power of the hypnotizer. Thus many attempts have been made to obtain from members of an order or society secrets relating thereto, and in not a single instance have they succeeded. On this ground, if for no other reason, the efficacy of hypnosis for this purpose may be doubtful.

I have now dealt with all facts properly appertaining to the topic under discussion. There remains, however, one more point which it may be worth our while to consider. Should the exercise of hypnosis be restricted by statute? Attempts have been made in this direction by the legislatures of some of our States, and in two, at least, of the European countries laws to that effect have been enacted. Thus, in Russia, a doctor who wishes to hypnotize must do so in the presence of two other doctors, and public exhibitions have been forbidden in Prussia.

It has been often urged that the practice of hypnosis be restricted to physicians. I do not see, however, why this should be done. It is certainly not because they are more advanced in the knowledge of its principles, since the study has until very lately been met on their part only with skepticism and derision. When we look at the great discoverers in this branch of science, we find them to have been the jest of the medical fraternity. Several times has the Academy of France denied the existence of hypnosis, and, until very lately, its practitioners have been treated as charlatans or mad enthusiasts. Any why should this power be less dangerous in the hands of physicians

than in the hands of others? If not because of their superior knowledge in the art, then for what reason? Is there such a monopoly of virtue among the medical fraternity that they alone can be trusted? Undoubtedly hypnotism may become at times a dangerous power, yet has it been shown that no advantage has ever been taken of their position by physicians, and are they alone exempt from human frailties?

Hypnotism is a word that is vague in import and of which it is exceedingly difficult to gather a clear conception. Were such a statute to be passed, the question as to whether the force used in any given case amounted to hypnotism or not would be exceedingly complicated and almost impossible to solve. Experts would differ among themselves and the law would become practically unenforceable. Furthermore, many people may hypnotize themselves, and to punish this as a crime would be to attempt the impossible. It seems better to place hypnotism within the same category as intoxicating liquors or explosives. Any person may purchase or own them, he is only to be held accountable for the manner of their use. Any one may publish a newspaper, but he must beware of what he puts therein. To prohibit its publication altogether because the crime of libel is sometimes committed by them would be the height of absurdity.

We have now examined that which has been presented for our consideration, especially with regard to the following questions: Has hypnotism any place in the civil or criminal law? May it be made use of for the purpose of eliciting testimony? Should laws restraining its exercise be passed?

For reasons which I have indicated above, I think that the above queries should be answered in the negative, and I believe that the majority of modern psychologists concur in this view. If, however, error has been committed by me, the chance for its demonstration will soon arise, since the matter is one which is bound shortly to be forced upon the courts and legislatures for their consideration.

Although great lawyers have recently expressed the opinion that the parole law under which convicts are permitted to serve a portion of their sentence outside the prison is unconstitutional, the grounds which they are reported to have urged in support of their views leave room for respectful dissent from their conclusions. In other words, the argument that the parole law is void because the indeterminate sentence law was void, is a non-sequitur, apparently.

There is no essential identity between the parole law and the indeterminate sentence law. The latter conferred distinctly judicial powers upon executive officers and deservedly fell the moment it was brought before a competent court. It proposed that the warden of the prison or the governor, or the pardon board, should fix the punishment to be imposed for crime, and not the judge of the trial court. The convict was sent to prison for no definite term, but was subject to unconditional release whenever it was thought advantageous by the executive in charge of him.

Now the parole law proposes nothing of that sort. It leaves the court to fix the term of imprisonment, and in no sense does it propose to have the sentence of the court superseded. What seems to be hard for the critics of the parole system to see is the vital fact that under it the convict is still in custody, although he be enjoying a condition which is identical with perfect liberty. Nor is that a technical construction to put upon the fact.

It is because the convict is virtually released while still constructively in custody that the parole system is valuable. It is because the person who has been shown too weak to resist the temptation to crime can be sent back into the world subject to summary arrest and imprisonment upon the infraction of the regulations of good behavior that much is expected of the parole system, and there is apparently no reason for thinking it confers undue powers, or puts upon anybody a duty in excess of his jurisdiction.—The American Lawyer.

THE FRENCH METHOD OF TREATMENT FOR ELECTRIC SHOCK.

THE prominent points of the circular which the Minister of Public Works in France has issued to the prefects throughout the republic on the measures to be taken in the event of an apparently fatal contact with live electric wires are the following, says the Electrical Engineer: The medical treatment of cases of shock is the same in all instances; but the steps to be taken for the preservation of the patient or the safety of the helpers are different according to whether the current is a continuous or an alternating or commutated alternating one. According to the Academy of Medicine the victim, even though apparently dead, must be at once taken, if no longer in contact with the electric wires, to a well-aired place, the number of persons in which is strictly limited to those whose services are necessary. The clothes are to be loosened (trousers and open shirt) and as promptly as possible you try to re-establish the respiration (as in the case of persons apparently drowned) by rhythmically pulling the tongue or by artificial respiration, and the circulation by rubbing the surface of the body, by whipping the trunk with the hands or with wet napkins, throwing cold water on the body from time to time, and by bringing ammonia or vinegar to the nose. The method for tongue pulling is to open the mouth, using force by any convenient means, if necessary, as by the handle of a knife or a piece of wood; to grasp the tongue solidly, preferably with the aid of a pocket handkerchief to prevent slipping; to pull the tongue forward, firmly and rhythmically, letting it slacken after each pull, about 20 times a minute; and keep this up for half an hour, an hour, or more. The method for artificial respiration is to lay the victim on his back, shoulders slightly raised, mouth open, tongue free; grasp the arms at the elbows, squeeze them firmly against the chest, then separate them and bring them above the head, describing an arc of a circle, then bring them back to their former position at the sides of the chest. Repeat this about 20 times a minute, and keep it up until natural respiration is restored. It is better to begin in every case with the tongue pulling, and, if possible, to carry on the artificial respiration at the same time. If the victim is still in contact with the wires the salvor must, before acting as

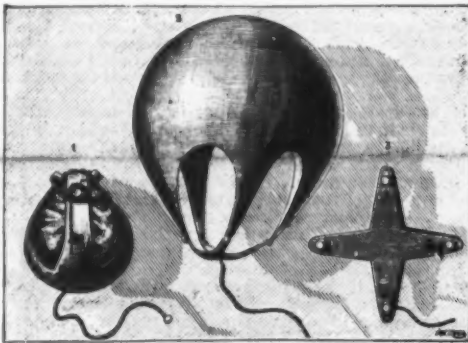
directed, get him away from these. But in order to do that, he must himself take certain precautions. For example, he must avoid touching him with the bare hands, and must wear thick gloves of dry stuff—linen and flannel of sufficient thickness; and he must not lay hold of the person injured by any wet or moist part of his body, as by his feet or under his arms. It may be necessary to cut the wires in order to free the body. But this is entirely inadmissible in the case of continuous currents, on account of the risk to the cutter occasioned by the spark or extra current on breaking circuit. It is not so with alternating or commutated alternating currents. In that case the wire may be cut without danger; but it is necessary to cut the wire on both sides of the victim in order to be sure that the cutting is really of use.

THE PARACHUTE BALL.

THE new game of ball that we are about to describe appears to possess a great attraction for children, for whom it constitutes an excellent exercise.

The ball, which differs from ordinary ones, as we shall presently see, is thrown into the air by means of a string which is fixed to it and that is made to revolve rapidly by hand with a sort of sling motion. An endeavor should be made to throw it as high as possible. So it should be left to itself at the moment that it reaches the vertical. Centrifugal force is thus utilized, and it is under the action of such force that the ball is capable of ascending to a great height. The ball is so arranged that at a certain moment of its ascension it becomes transformed of itself, and presents a wide surface to the air in becoming a miniature parachute. So the apparatus operates like a ball during its ascent, which is very rapid, and like a parachute during its descent, which is very slow. Hence the name of "parachute ball" given it by its inventor.

The apparatus, moreover, clearly shows the role of the resistance of the air to the motion of bodies. It fixes in the mind of children the fact that the resistance that the air opposes to the displacement of movable bodies varies with the surface that the latter offer to it. The interest that the parachute ball presents from this point of view results from the fact that the transformation of the ball, that is to say, an object of small surface, into a parachute of wide surface, is effected spontaneously in the air. It is therefore possible to compare the resistance of the air upon the same body, whether it presents a small external surface or a wide one. The plaything, therefore, constitutes



THE PARACHUTE BALL.

1. Appearance of the ball at the moment that it is thrown. 2. Aspect of the parachute during its descent. 3. Star of the parachute ball.

a true apparatus of scientific demonstration, and as such it has appeared to us of interest to make it known.

The apparatus, which is exceedingly simple, consists of a sort of very light silk handkerchief whose four corners are connected with the four branches of a rubber star. The handkerchief is folded very compactly and inclosed between the four branches of the star, which are turned up so as to constitute a sort of ball. To one of the branches of the star is fixed an elastic string which is made to pass beneath a rubber projection carried by the extremity of each branch of the star. These projections are marked 1, 2, 3 and 4 in Fig. 3. The elastic, starting from 4, passes under 1, 2, 3 and 4, and, at 5, enters a groove in the first projection, and then passes under a hook, 6, which fastens it. The apparatus is then capable of operating like a ball, of which, moreover, it has the aspect. The elastic is not permanently fixed beneath the hook, but gradually expands and, after a certain length of time, makes its exit therefrom. At this moment the star, by virtue of its elasticity, returns to its pristine form, and the handkerchief assumes the aspect of a small balloon, which falls slowly (Fig. 2). Under such circumstances the child can follow the apparatus with his eyes and find it at the place where it falls.

It is easy to understand what the best possible conditions are for the operation of the parachute ball. It must operate like a ball as long as it is capable of ascending, and, consequently, during the whole time of the ascent the elastic must expand and not make its exit from the hook until it has reached the end of its upward travel. It is not until this moment that the apparatus can operate as a parachute. The skill of the player consists in taking advantage of the precise moment in which it is well to throw the ball in order to obtain the maximum effect. If it is thrown too soon, the apparatus will descend in part as a ball and operate but slightly, or not at all as a parachute. If it be thrown too late, the ball will at once develop into a parachute and, under such circumstances, will not reach much of a height. With a little practice, it is possible to throw the ball to a height of sixty or ninety feet. Sometimes, even, with a strong initial impulsion, the apparatus is capable of being sent still higher. The apparatus under such conditions becomes interesting, not only to young children, but also to those of older growth. The parachute ball constitutes a very light and, consequently, harmless plaything, since, if it strikes a person, it can produce but

an insignificant effect, either when it is thrown or when it falls. Its operation is very simple. It brings the skill of the child into play, without, however, presenting difficulties of handling great enough to discourage an awkward player. Satisfactory results are quickly reached. At a time when the question of balloons and the study of aerial phenomena is the order of the day, it is natural to try to make children observe the phenomena of the atmosphere, considered as a future vehicle for man, by means of playthings like the one that we have just described, and in which the child can learn by sight the operation of the parachute. Perhaps by such means it will be possible for us to develop in the rising generation a taste for aeronautics.—La Nature.

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